BULLETIN OF THE IMPERIAL INSTITUTE

A RECORD OF PROGRESS RELATING TO AGRICULTURAL, MINERAL AND OTHER INDUSTRIES, WITH SPECIAL REFERENCE TO THE UTILISATION OF THE RAW MATERIALS OF THE DOMINIONS, COLONIES AND INDIA

VOL. XXXI. 1933

LONDON
JOHN MURRAY, ALBEMARLE STREET, W.

Printed in Great Britain by
Hazell, Watson & Viney, Ltd., London and Aylesbury.

BULLETIN OF THE IMPERIAL INSTITUTE

VOL. XXXI. 1933

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THE IMPERIAL INSTITUTE

South Kensington, S.W.7

GENERAL INFORMATION

The Imperial Institute was founded as the Empire Memorial of the Jubilee of Queen Victoria. Its principal object is to promote the development of the commercial and industrial resources of the Empire.

Under the provisions of the Imperial Institute Act of 1925, the Institute was reorganised and placed under the control of the Department of Overseas Trade. The Parliamentary Secretary of that Department is the responsible Minister and is President of the Board of Governors. This body consists of the High Commissioners of the Dominions and India, representatives of the Colonial Office and certain other Government Departments, and of the Crown Agents for the Colonies, with additional members representing scientific and commercial interests. The Director of the Institute is Lieut.-Gen. Sir William Furse, K.C.B., D.S.O.

The technical work of the Institute is carried out by two principal Departments, viz., a Plant and Animal Products Department and a Mineral Resources Department. An Advisory Council for each of these groups of products has been appointed, Sir David Prain, C.M.G., C.I.E., F.R.S., being Chairman of the Plant and Animal Products Council, and Sir Richard Redmayne, K.C.B., Chairman of the Mineral Resources Council.

A number of Advisory Technical Committees consisting of authorities on the various groups of raw materials co-operate in the work of the Institute, in association with the Advisory Councils, and a close touch is main-

tained with producers, users, merchants and brokers. Valuable help can thus be given by the Institute to persons interested in the development of the resources of raw materials throughout the Empire.

Intelligence.—The Institute maintains a special service for dealing with enquiries relating to the sources, production, uses and marketing of raw materials and for collecting and disseminating general and statistical information on these subjects. This service is available for the use of individuals and firms, as well as of Government Departments, without charge.

Investigations.—The laboratories of the Institute are specially equipped for the chemical and technical examination of raw materials of all kinds. Full reports are furnished on the composition, uses and value of materials submitted. By its close association with the users of raw materials, the Institute is able to arrange large-scale trials of promising materials when necessary.

Special analyses and investigations are undertaken for firms or private persons in any part of the Empire on payment of appropriate charges. Applications for such investigations should be addressed to the Director.

Investigations on plantation rubber are conducted at the Institute under the supervision of the London Advisory Committee of the Ceylon Rubber Research Scheme and the Rubber Research Institute, Malaya.

Library.—The Library of the Institute contains a large collection of works of reference relating to Empire countries and their products and is regularly supplied with the more important reports and other publications of Government Departments in Great Britain, the Dominions, Colonies and India, and most foreign countries. More than 800 serial publications, mainly of a scientific or technical character, are also regularly received.

The library is available for the use of enquirers between the hours of 10 a.m. and 5 p.m. on week-days (10 a.m. and 1 p.m. on Saturdays).

Statistical Section.—This section is concerned with the collection of statistics required in connection with the work of the Institute.

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Other publications of the Institute include handbooks on "The Agricultural and Forest Products of British West Africa" and "Cotton and Other Vegetable Fibres"; Reports of the Indian Trade Enquiry; a Descriptive List of Some Empire Timbers; a Monograph on the Tanning Materials of the British Empire; Monographs dealing with the Mineral Industry of the British Empire and Foreign Countries as well as a statistical series relating thereto; and a series of volumes on the Mining Laws of the British Empire and Foreign Countries.

Public Exhibition Galleries.—These galleries serve as a permanent exhibition of the natural resources, scenery and life of the people of the Dominions, Colonies and India. It is the only exhibition of the kind in the world where the countries of the Empire are represented under one roof.

A special feature has been made of pictorial representation, which takes the form of illuminated dioramas, transparencies and photographs. These are intended to attract the non-technical visitor and children, and to awaken in them an interest in the raw products which are shown in association with the illustrations. Descriptive labels are attached to all exhibits explaining in simple language their origin, occurrence, methods of cultivation or preparation, and uses. To render the galleries of

further assistance to teachers in the study of Empire geography and development, the exhibits are arranged in a definite sequence as suggested by the Advisory Education Committee of the Imperial Institute. Lectures and demonstrations in the galleries are given daily to school teachers and school children by the Guide Lecturers.

At the Central Stand which is maintained in the galleries for enquirers, free literature relating to Empire countries and products is distributed, and other publications and picture postcards are on sale.

In the Exhibition Pavilion, attached to the Galleries, temporary exhibitions of special products are held.

The galleries are open free daily from 10 a.m. to 5 p.m. and on Sunday afternoons from 2.30 to 6 p.m.

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REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

Selected from the Reports made to the Dominion, Colonial and Indian Governments

AGAVE AMANIENSIS FIBRE FROM TANGANYIKA

THE sample of fibre which is the subject of this report was forwarded by the Director of the East African Agricultural Research Station, Amani, in September, 1932.

The material had been obtained from the leaves of a species of Agave found at Amani bearing the label "*A. Lespinassei.*" It has been found, however, that the plant is not this species and it is being provisionally termed *A. amaniensis.* The sample represented the second cutting of leaves, and was sent for examination in continuation of the investigation of a sample from the first cutting, which had been forwarded in March, 1932. As in the latter case, the material had been extracted by means of a "Corona" machine.

In forwarding the sample the Director of the Research Station stated that it had been prepared at the Amboni Estate through the kind offices of the Manager, Mr. J. Tanner. It was reported that 1,500 leaves, of a total weight of 1,225 kilos., yielded 37·4 kilos. of brushed fibre and 3·4 kilos. of unbrushed tow, and that it was considered that better results might be obtainable if the Corona machine were specially adjusted for the material. The Director added: "I shall be grateful if you will submit this sample for the consideration of your Fibres Committee, or take such other action with regard to it as may be productive of information regarding its possible uses and the extent of the demand which might be expected to exist if it is developed

on a commercial scale. I am inclined to think that it may assume considerable importance through the extension of the uses to which sisal as at present grown can be applied, seeing that it can be grown under the same conditions and treated by the same machinery. The possibly lower fibre content would, according to present appearances, be much more than compensated by the greater rapidity of growth. Possibly also its poling propensity may be much less than that of sisal, as, so far as we are aware, it has not yet poled at Amani."

The sample weighed 75 lb. and consisted of very clean, well-prepared, fairly lustrous fibre, varying in colour from pale yellowish-cream to white. On the whole, the material possessed good strength. The length of the strands ranged from 4 to 5½ ft.

A representative portion of the sample was chemically examined with the following results, which are shown in comparison with those obtained for the previous sample mentioned above and with the range of corresponding figures obtained at the Imperial Institute for No. 1 Brushed East African Sisal :

		A. amaniensis. Present Sample. *Per cent.*	*A. amaniensis.* Previous Sample. *Per cent.*	East African Sisal No. 1. Brushed. *Per cent.*
Moisture		10·9	10·8	9·3– 9·9
Expressed on the moisture - free fibre	Ash	0·9	1·0	0·5– 1·2
	a-Hydrolysis, loss	12·2	11·4	10·2–11·6
	β-Hydrolysis, loss	14·4	14·0	12·3–14·4
	Water-washing, loss	2·5	0·7	1·0– 2·4
	Cellulose	73·7	75·5	77·0–79·8

These results show that the present material contained rather less cellulose than samples of first-grade East African sisal examined at the Imperial Institute, but that no important differences were observed in the losses on hydrolysis. The amount of cellulose was a little lower than that obtained with the previous sample from Amani.

The fibre was submitted to a firm of merchants in London (Messrs. Wigglesworth & Co., Ltd.), who furnished the following report :

"This is a well-grown material of 55/60-in. length, in this respect being substantially longer than the average Sisal produced from *Agave sisalana*. The material has

been well decorticated, and is of superior white colour, glossy fibre, containing some fluff which we judge from the report by Mr. Tanner might be eliminated if the Corona machine was specially adjusted to the material. The fibre is rather finer than Sisalana and would be thoroughly suitable for fine spinning and ply twines. The top end of the material is much softer than in the case of Sisalana, and the strength is proportionate.

"We consider this material is above the quality of good No. 1 African and should be readily saleable at a premium on the market for No. 1 African Sisal, which at to-day's exceptional price is £14 10*s.* compared with the average price over the last five years of £31 10*s.*

"The fibre could be sold in unlimited quantities in competition with other Sisal. The only point for the growers to consider is whether the yield and rapidity of growth and the length of life of the plant may prove superior to that of *Agave sisalana* as now cultivated in East Africa."

The material was also submitted to a rope-maker, who considered it to be of very promising quality and offered to carry out a trial with it for the manufacture of yarn or rope if a quantity of about 5 cwt. could be supplied for the purpose.

THE COMPOSITION OF NIPA PALM SEEDS

The Nipa palm (*Nipa fruticans* Thunb.) is a plant of wide distribution in the Eastern tropics, often occurring in large stands unmixed with other vegetation along river deltas and on land adjacent to tidal rivers which is flooded at each rise of the tide. Like other palms which are available in large quantities, the Nipa finds many uses amongst the native population, chief of which perhaps, especially in the Philippine Islands, is the preparation of an alcoholic beverage from the juice of the inflorescence. This juice is rich in sugar and efforts have been made to utilise it as a source of this commodity. For details as to these aspects of the Nipa palm reference may be made to the following articles and notes which have been published in this Bulletin:

"The Nipa Palm as a Source of Sugar and Alcohol," Vol. XX (1922), No. 3, pp. 315–325.

"The Production of Alcohol for Motor Fuel from the Nipa Palm in North Borneo," Vol. XXIII (1925), No. 2, pp. 175–181.

"The Nipa Palm as a Source of Alcohol in Malaya," Vol. XXVI (1928), No. 2, pp. 161–163.

"The Manufacture of Sugar from Nipa Sap," Vol. XXVIII (1930), No. 1, pp. 58–60.

The immature seeds of the palm appear to be used in some countries as a food, whilst in the Philippines they are also sometimes made into a kind of sweetmeat. The mature seeds are stated to be too hard to be eaten.

With a view to ascertaining the composition and feeding value of the seeds, a small supply of mature and immature seeds (kernels) was recently furnished to the Imperial Institute by Messrs. Nipa Distilleries of Malaya, Ltd., who own a large area of land planted with the palms in Selangor. A few whole fruits were also supplied. The company state that under the system of cultivation and irrigation practised on the estate the fruiting of the palms is most prolific. Each palm produces a number of flowering stalks, up to a dozen or more, only two of which are tapped for the sap; the remainder produce large bunches of fruit. The total production of nuts is therefore very considerable and has been estimated at over 30,000 tons per annum, and at present they are entirely a waste product.

The material received at the Imperial Institute was as follows:

A. *Whole Fruits.*—Pointed fruits, split into halves, measuring 4½ in. long and 2 to 3 in. broad. Externally the fruits were reddish-brown. They consisted of a thick layer of fibrous husk enclosing a single seed (kernel) of obovoid shape, 1¾ in. long and 1¼ in. broad. The seeds were white, opaque and rather discoloured; they were very hard and had a central cavity.

B. *Seeds (Kernels) from Mature Fruits* (4 *months old*).—Half-kernels, similar in appearance to those in the whole fruits, 1½ to 1¾ in. long and 1¼ in. broad.

C. *Seeds (Kernels) from Immature Fruits cut when the Palms are tapped (about 3 months old).*—Kernels much smaller than the mature ones of sample B, and measuring only $\frac{3}{4}$ to 1 in. long by $\frac{3}{8}$ to $\frac{5}{8}$ in. broad. They were translucent and varied in colour from yellowish-brown to reddish-brown.

Samples B and C were analysed with the following results :

	Sample B. Mature Kernels. *Per cent.*	Sample C. Immature Kernels. *Per cent.*
Moisture	10·2	8·2
Crude proteins	3·6	4·4
Fat	0·4	1·1
Ready-formed reducing sugars (expressed as dextrose)	0·9	3·7
Sugars reducing only after inversion (expressed as sucrose)	0·8	0·9
Starch	nil	nil
Other carbohydrates (by difference)	78·0	71·1
Crude fibre	4·5	6·6
Ash	1·6	4·0
Nutrient ratio	1 : 22·4	1 : 17·8
Food units	90	89

These results show that the mature and immature kernels are generally similar in composition. The only marked difference between them is that the immature kernels (C) contain more ready-formed reducing sugars. The amounts of proteins and sugars in both samples are low and neither contains any true starch.

The composition of the kernels indicates that they are only of moderate value as a feeding-stuff. They might, however, be utilised locally if trials show them to possess no harmful properties.

The dry kernels as received were very tough and horny, and difficult to grind. They would possibly be more readily dealt with when in fresh condition.

ACORN CUPS FROM PALESTINE

THREE samples of acorn cups which were stated to have been collected in different districts of Palestine were forwarded to the Imperial Institute by the Director of Agriculture and Forests in February, 1932. A fourth sample was forwarded in July, 1932.

The samples, the first three of which were accompanied by corresponding specimens of the wood of the trees, were as follows :

No. 1.—Greyish-brown acorn cups, 1 to 1½ in. in diameter and 1 to 1⅜ in. in height. The cups were covered with " beard " measuring up to ¼ in. in length.

No. 2.—Acorn cups similar to the foregoing in general appearance, but somewhat smaller, being ¾ to 1¼ in. in both diameter and height.

No. 3.—Acorn cups generally similar to Nos. 1 and 2, but on the whole smaller, the height and diameter both varying from ½ to 1⅛ in.

No. 4.—Acorn cups of similar appearance to the preceding, but ¾ to 1½ in. in diameter and 1 to 1½ in. in height.

The first three samples of acorn cups and wood were submitted to the Royal Botanic Gardens Kew, and the following report was received :

" Dr. Turrill has examined the acorn cups and writes as follows : ' So far as I can tell these are all *Quercus ithaburensis* Ky., reduced by Boissier (Flor. Or.) to a variety of *Q. Ægilops*, but it is distinct from the typical *Q. Ægilops* L.' "

Herbarium specimens, which accompanied the fourth sample, were also submitted to Kew and identified as *Q. ithaburensis* Ky.

The samples were examined with the following results, which are shown in comparison with the corresponding figures recorded for commercial Smyrna and Greek Valonea (*Quercus Ægilops*) :

	Present Samples.				Smyrna	Greek
	No. 1.	No 2	No. 3	No 4	Valonea.[1]	Valonea.[1]
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Moisture	13·4	12·2	12·0	14·0	12·0	12·0
Insoluble matter	58·4	58·4	56·5	61·3	43·1	42·9
Extractive matter (non-tannin)	8·2	9·9	11·0	8·7	12·5	13·0
Tannin	20·0[2]	19 5[2]	20·5[2]	16·0[2]	32·4	32·1
Ash	2·5	2·9	3·7	3·0	—	—
[3] Tintometer readings :						
Red	5·7	5·4	4·4	16·7	1·6	1·5
Yellow	21·4	22·6	20·9	72·1	5·6	5·0

[1] *Calculated to 12 per cent. of moisture*

[2] *Carried out by the Official International Method of Tannin Analysis (Hide Powder Batch C 3)*

[3] *Determined for a solution containing 0·5 per cent. tannin in a 1-cm. cell.*

Tanning extracts prepared from the first three samples all furnished leathers of yellowish-brown colour, plump, very firm and of close grain ; the leather was similar in character to that obtained with commercial valonea, but rather darker. The leather furnished by a tanning extract prepared from the fourth sample was similar to the earlier ones, but darker in colour and considerably darker than that furnished by commercial valonea.

The results in respect of the first three samples were submitted to the Imperial Institute Advisory Committee on Tanning Materials for observations on the commercial possibilities of the acorn cups. The Committee agreed that the amounts of tannin in the samples were too low in comparison with the quantity found in commercial valonea (30 to 35 per cent.) for the products to be saleable in the United Kingdom, but they considered that such acorn cups might be employed in Palestine for the production of tanning extract for export. The fourth sample contained even less tannin, and owing to the rather dark colour of the leather produced, they would not be so satisfactory for the manufacture of tanning extract.

CEMENT-MAKING MATERIALS FROM BORNU PROVINCE, NIGERIA

IMPORTED Portland cement is an expensive building material in parts of the Empire remote from centres of production, and the employment of local materials for the manufacture, on the spot, of natural or other hydraulic cement, is often well worth consideration. The Imperial Institute has, on many occasions, been able to render valuable assistance to various Colonies and Protectorates by carrying out the analysis and technical tests on their raw materials for cement manufacture ; an account of an important investigation of this nature, made for the Nyasaland Government, has been given in this BULLETIN (1932, **30**, 139–159).

A number of samples of cement-making materials from Bornu Province, Nigeria, have recently been examined at

the Institute, and an account of the investigation carried out in this instance may also be of interest.

Description of Samples

The samples, which had been collected by Mr. G. J. Kingsnorth of the Bornu Native Administration, were as follows :

No. 3. "Jigalin" nodules.—These calcareous nodules are said to occur, in large quantities, over wide areas of Bornu.

It was desired to ascertain whether they were capable, after appropriate treatment, of yielding a better hydraulic cement than that made locally experimentally, a sample (No. 4) of which was also forwarded for examination.

Samples of "Jigalin" were sent for examination on two different occasions during the course of this investigation.

No. 4. Ground "Jigalin."—This consisted of "Jigalin," burnt in Nigeria by means of a blow-lamp for about ¾ hour after mixing with alternate layers of cowdung and charcoal. This material was said to set under water.

No. 5. Cowdung and Charcoal.—These were sent as examples of the fuel used in burning the "Jigalin."

No. 6. Impure Limestone.—Extensive outcrops of this impure fossiliferous limestone are said to occur in the south-west of Bornu over an area of 500 square miles, the depth of the strata being probably over 100 ft.

This material was sent in order to have investigated its suitability for making building lime or natural cement, or for the preparation of Portland cement in conjunction with either "Jigalin," No. 3, or with mud, No. 9. Two samples of this limestone were forwarded on different occasions.

No. 9. Mud.—It was desired to know whether this material, which consisted of a highly siliceous buff-coloured clay, was suitable for making Portland cement in conjunction with the impure limestone, No. 6.

Nos. 10 and B. Limestones.—These samples, sent at different times, represent siliceous limestones, similar in

character. Material of this type is stated to occur at many places in the desert. It was desired to know whether such material would be suitable for making hydraulic lime.

Sample A. Clay.—Information was desired on the suitability of this dark grey siliceous clay for Portland cement manufacture in conjunction with the limestone, No. 6.

Sample C. Bornu Ironstone.—This material, which is said to occur in large quantities near the "Jigalin" deposits, was suggested for use in the manufacture of a type of iron-Portland cement. The sample received consisted of a mixture of pisolitic iron ore and a ferruginous slag-like material. For the investigation the two types of material were bulked and treated as one sample.

Chemical Analyses of Samples

The above-mentioned materials (except the cowdung and charcoal) were submitted to chemical analysis with the results shown on page 10, Table I.

Results of Technical Trials

"Jigalin" nodules, No. 3

(*a*) *Preparation of natural cement from first sample of "Jigalin."*—The material was first burnt to a temperature of about 900° C. A portion of the product was slaked, ground to pass a 30-mesh sieve, briquetted, and reburnt at a temperature of approximately 1,050° C. It was found that slaking the product obtained by burning at 900° C. did not disintegrate it sufficiently to obviate the necessity for further grinding.

The results of the tests of the products made by the above-mentioned single and double burnings are shown on page 11, Table II. For purposes of comparison, the burnt products, before testing, were ground as nearly as possible to the same fineness as that of the locally made ground "Jigalin," No. 4, and the resulting materials were tested both neat and in admixture with British Standard cement-testing sand.

TABLE I

CHEMICAL ANALYSES OF CEMENT-MAKING MATERIALS FROM BORNU PROVINCE

(Percentages)

		"Jigalm," No. 3.		Ground "Jigalm," No. 4.	Impure limestone, No. 6.		Mud, No. 9.	Clay, Sample A.	Calcareous material, No. 10.	Calcareous material, B.	Bornu ironstone, Sample C.
		1st Sample.	2nd Sample.		1st Sample.	2nd Sample.					
Silica	SiO_2	22·49	27·85	33·58	7·15	7·85	78·16	56·98	33·68	33·81	13·57
Alumina	Al_2O_3	3·37	4·70	4·05	3·39	3·44	9·74	19·05	1·63	2·17	6·69
Ferric oxide	Fe_2O_3	1·71	1·34	1·55	1·87	2·45	2·40	6·49	0·52	1·02	70·00
Manganous oxide	MnO	—	—	—	—	—	—	—	—	—	0·43
Titanium dioxide	TiO_2	0·32	0·28	0·30	0·15	0·12	0·69	0·78	0·11	0·13	0·24
Lime	CaO	31·17	33·96	30·90	45·93	46·61	0·61	1·22	33·46	32·82	2·27
Magnesia	MgO	6·52	1·40	4·26	0·89	0·83	0·48	0·92	0·80	0·71	0·45
Sulphuric anhydride	SO_3	0·10	—	0·11	0·07	—	0·04	—	0·11	—	—
Phosphoric anhydride	P_2O_5	—	—	—	0·40	—	—	—	—	—	—
Loss on ignition		32·98	29·87	24·50	39·16	38·49	5·17	13·17	29·56	29·23	6·28

TABLE II

NATURAL CEMENT FROM "JIGALIN" (1ST SAMPLE)

Tensile Strength (lb per sq in)

	Single Burning Burnt 3½ hours at 900° C, slaked, and ground to leave a residue of 42 per cent on a sieve having 180 meshes per linear inch						*Double Burning* Burnt 3 hours at 900° C, slaked, ground, briquetted and reburnt for 3½ hours at 1,050° C., finally slaked and ground to leave a residue of 41 per cent on a sieve having 180 meshes per linear inch.					
	Neat cement Gauged with 41 per cent of water			3 parts standard sand to 1 part of cement by weight Gauged with 13.4 per cent of water			Neat cement Gauged with 31.5 per cent of water			3 parts standard sand to 1 part of cement by weight Gauged with 11.7 per cent of water		
	28 days	56 days	91 days	28 days	56 days	91 days	28 days	56 days	91 days	28 days	56 days	91 days.
Mean of six results . .	115	165	187	39	92	114	56	189	260	18	56	98

The neat cement prepared from the material burnt at 900° C. had an initial setting time of 26 hours and a final setting time of 48 hours, while that produced by the double burning had an initial setting time of 6 hours 30 minutes and a final setting time of 60 hours.

It will be seen that the double burning resulted in an increase of about 40 per cent. in the strength of the neat cement when tested at 91 days after gauging. The sand-cement briquettes, however, although showing rapidly increasing strength, were not quite equal in that respect to the corresponding briquettes made from the once-burnt material.

The tensile strength of the cement produced by either method of burning, though equal to that of many moderately hydraulic limes, is much below that of an average natural cement, the tensile strength of which, after 28 days, should be, for neat cement, about 225 lb. per sq. in., and for the sand-cement, about 125 lb. per sq. in.

(*b*) *Preparation of natural cement from a second sample of "Jigalin."*—It will be seen from the analyses in Table I, that the second sample of "Jigalin" differed considerably in composition from that of the first sample received. This is more clearly shown by a comparison of the analyses of

the two samples when both are calculated on a loss-free basis.

TABLE III

Chemical composition of "Jigalin," No. 3

		1st Sample. Per cent.	2nd Sample. Per cent.
Lime	CaO	46·51	48·40
Magnesia	MgO	9·75	2·00
Ferric oxide	Fe_2O_3	2·55	1·91
Alumina	Al_2O_3	5·03	6·70
Titanium dioxide	TiO_2	0·47	0·45
Silica	SiO_2	33·56	39·69
Sulphuric anhydride	SO_3	0·15	—
Undetermined	—	2·00	0·85

It was stated, with reference to the second sample, that better results had been obtained locally with this material by a longer period of burning than was originally adopted. This sample when tested at the Institute was, therefore, broken down to lumps about 1 in. in diameter and burnt in a gas-fired furnace at a temperature of 900° C. for 11 hours, instead of for about 3 hours, as in the single burning of the first sample, described on page 9.

It was found that owing to the irregular distribution of the calcium carbonate in the raw material, the burnt product contained a considerable amount of uncombined lime, and in order to obtain a cement which should be free from a tendency to expand after gauging, it would be necessary to render this free lime innocuous. This could be done either by grinding the burnt "Jigalin" and aerating it in layers, or by thoroughly damping it in heaps with water so as to slake the highly calcareous portions, thereby breaking down the lumps to some extent and effecting economy in grinding.

During preliminary burning trials it was found that the slaked material when ground and made into a paste with water set in about 2 hours, while the material ground directly after burning and left to slake in air for 17 days set in 5 minutes. It was therefore concluded that, in practice, it might be possible to adjust the setting time of the product by slaking part of it with the minimum quantity of water and grinding the slaked lumps with some of the freshly burnt material.

The product obtained on burning the "Jigalin" for

11 hours at 900° C. was treated in this way, equal parts of the slaked and unslaked products being ground together until a residue of 13·4 per cent. remained on a sieve having 180 meshes per linear inch. Two per cent. of gypsum was mixed with the ground material in order to lengthen the setting time. It was found, however, that the cement thus produced still set very quickly, its initial setting time being 7 minutes and its final set 10 minutes.

Though the proportion of slaked material used in this case proved insufficient to lengthen the setting time, it is possible that for work on a large scale such a method, combined perhaps with the addition of about 2 per cent. of gypsum, might be found practicable for that purpose. The amount of water used for slaking should be limited, as an excess would result in hydration of the cement itself as well as that of the free lime, with a consequent reduction in the strength of the material.

The cement produced as described above was tested for tensile and compressive strength, both neat and when mixed with 3 parts of British Standard cement-testing sand. Details of these tests are given below.

The briquettes for the tensile test, whether composed of neat cement or of cement and sand, were made by thumb-pressing the respective materials, after they had been gauged with water, into the moulds. The briquettes were left in the moulds in a damp atmosphere for 24 hours, after which they were removed and stored in water until due for breaking at 28, 56, 91 and 182 days from the date of gauging. The results are shown below.

TABLE IV

NATURAL CEMENT FROM "JIGALIN" (2ND SAMPLE)

Tensile Strength (lb per sq in)

	Neat Cement Gauged with 40 per cent of water				3 Parts standard sand to 1 part of cement by weight. Gauged with 13·2 per cent of water			
	28 days.	56 days.	91 days	182 days	28 days.	56 days.	91 days.	182 days.
Mean of six results	148	196	216	235	114	148	178	203

The compression test was carried out on two series of cubes, composed respectively of neat cement and of 3 parts by weight of British Standard cement-testing sand to 1 part of cement, which were gauged and treated in a manner exactly similar to that used for the tensile test briquettes. The results of the compression tests are shown below.

TABLE V

NATURAL CEMENT FROM "JIGALIN" (2ND SAMPLE)

Compressive Strength (lb. per sq in.)

	Neat Cement.				Cement with 3 parts of standard sand.			
	28 days.	56 days	91 days	182 days.	28 days.	56 days.	91 days.	182 days.
	645	Not made	1,379	1,655	418	839	882	1,062
	690		1,566	1,999	348	775	832	1,102
	—		—	—	403	745	975	1,032
Mean . .	668	—	1,473	1,827	390	786	896	1,066

Compressive Strength of Concrete made from "Jigalin" Natural Cement

A mixture consisting of 1 volume of "Jigalin" cement, 1½ volumes of sand (particles from ¼-in. diameter downwards) and 3 volumes of coarse ballast aggregate (retained on a ¼-in. mesh sieve and passing one of ¾-in. mesh), equivalent to 5·2 lb. cement, 11·75 lb. sand and 23·5 lb. of ballast respectively, was gauged with 11·4 per cent. by weight of water, and the mixture filled into 6-in. cube moulds. The cubes, so made, were left in the mould in a damp atmosphere for 24 hours, after which they were removed and stored in damp sand until due for crushing, i.e. at the expiration of 28 days and 91 days respectively from the date of gauging. When crushed they gave the following results :

Compressive Strength (lb. per sq in.)

After 28 days ageing	163
,, 91 ,, ,, ...	323

It will be seen (page 13) that the results of the neat tensile test agree very closely with those of the corre-

sponding tests made on the locally burnt and ground "Jigalin," No. 4, after it had been reground at the Imperial Institute to approximately the same fineness as in the present instance, whereas the tensile strengths of the briquettes made from the 3 : 1 sand-cement mortar are very much higher than those of the corresponding sand-cement briquettes incorporating the local material.

The tensile and compressive strengths of the neat cement and sand-cement mortar, and also the compressive strength of the concrete, are equal to those of a moderately hydraulic lime or of some of the weakest natural cements, but are much below the average for the latter type of material.

No. 4. Locally burnt and ground "Jigalin"

The high percentage of loss on ignition shown in the chemical analysis of this sample (Table I) indicates either that the burnt material had absorbed water and carbon dioxide, or that the burning had been incomplete.

It will be seen that the ratio of silica and alumina to lime is much higher in this sample than in the "Jigalin" nodules. The differences in composition are more clearly seen if both analyses are calculated on a loss-free basis, as shown below:

TABLE VI

		"Jigalin" Nodules, No. 5 (first sample). *Per cent.*	Ground "Jigalin," No. 4. *Per cent.*
Lime	CaO	46·51	41·00
Magnesia	MgO	9·75	5·66
Silica	SiO_2	33·56	44·60
Alumina	Al_2O_3	5·03	5·37
Ferric oxide	Fe_2O_3	2·55	2·06
Titanium dioxide	TiO_2	0·47	0·39
Sulphuric anhydride	SO_3	0·15	0·12

From theoretical considerations, ground "Jigalin," No. 4, might be expected to possess weaker hydraulic properties than the burnt product obtained from No. 3, in which the ratio of silica and alumina to lime is already higher than is desirable in material intended for the production of a good natural cement.

The sample as received was found to leave a residue of 40 per cent. on a sieve having 180 meshes per linear inch. When gauged with water it yielded a product which set very slowly, a pat placed in water three weeks after gauging being very soft after six weeks' immersion.

Briquettes were made from the ground "Jigalin" as received, both neat and in admixture with standard cement-testing sand, and also from the material reground to such fineness that a residue of 13 per cent. was left on a 180-mesh sieve. The tensile strengths of these briquettes were determined at periods of 28, 56 and 91 days after gauging. The results are shown on page 17, Table VII.

Tests were also made to ascertain the effect of reburning the ground material at a higher temperature than that employed locally. In these trials the material as received was moistened with water and made into briquettes, which were dried and burnt at a temperature of 1,050° C.

The burnt product was slaked, ground to such fineness that a residue of 49 per cent. was left on a sieve having 180 meshes per linear inch, and then tested for tensile strength, both neat and when mixed with three parts by weight of British Standard cement-testing sand. The results obtained are also shown in Table VII.

The locally burnt material, as received, had an initial setting time of 19 hours and a final setting time of 96 hours when gauged with 27·5 per cent. of water. After further grinding to a fineness of 13 per cent. residue on a 180-mesh sieve, these periods were 20½ and 92 hours respectively, while in the case of the reburnt sample they were 26 and 84 hours.

The results show that the strength of the reburnt and coarsely ground material, under the neat test, 56 and 91 days after gauging, was practically the same as that obtained on the corresponding test of the material after further grinding, while the strength of either of these products, after the same periods of ageing, was much greater than that of the sample as received.

The improvement shown in the sand tests of the reburnt material was, however, very pronounced, and it is probable that further strength would have been shown if the product had been more finely ground. Equally good

TABLE VII

NO. 4, GROUND "JIGALIN"

Tensile Strength (lb. per sq. in.)

	Locally burnt material. Fineness of grinding: 40 per cent. residue left on a 180-mesh sieve						*Locally burnt material.* Reground to leave a residue of 13 per cent. on a 180-mesh sieve.						*Locally burnt material.* Reburnt at a temperature of 1,050° C., slaked and ground to leave a residue of 49 per cent. on a 180-mesh sieve.					
	Neat cement. Gauged with 27·5 per cent. of water.			3 parts standard sand to 1 part of cement by weight. Gauged with 11·1 per cent. of water			Neat cement. Gauged with 27·5 per cent. of water.			3 parts standard sand to 1 part of cement by weight. Gauged with 11·1 per cent. of water.			Neat cement. Gauged with 42 per cent. of water.			3 parts standard sand to 1 part of cement by weight. Gauged with 13·5 per cent. of water.		
	28 days.	56 days.	91 days.	28 days.	56 days.	91 days.	28 days	56 days	91 days.	28 days	56 days	91 days.	28 days.	56 days.	91 days.	28 days.	56 days.	91 days.
Mean of six results . .	111	169	176	19	24	28	158	194	230	39	46	44	104	180	233	49	101	148

results might not have been obtained if the original "Jigalin," from which the ground material was made in Nigeria, had been subjected to a single burning, in lump form, at 1,050° C. in the first instance, since, when it was reburnt at the Imperial Institute, the calcareous and acid constituents had already been brought into more intimate contact by the grinding which the material had undergone before the second burning was made.

A comparison of the results in Table II with those in Table VII above shows that the "Jigalin" nodules burnt at the Imperial Institute at 900° C. gave a product only slightly stronger under the neat test than the locally burned material, but much superior in strength, when mixed with sand, to the latter material under the same conditions.

Cowdung and Charcoal as Fuel

In order to reproduce the conditions under which the ground "Jigalin" made in Nigeria had been produced, a trial burning was made of a small quantity of "Jigalin" mixed in alternate layers with cowdung and charcoal in a gas-fired furnace. After the ignition of the fuels had commenced the gas was shut off and the burning continued with the aid of a forced draught of air. A temperature of about 1,000° C. was attained.

The product when ground, mixed with 3 parts by weight of British Standard cement-testing sand, and gauged with water, had a tensile strength, after 56 days' ageing in damp air and water, of 71 lb. per sq. in. This was much higher than that given by the corresponding mixture of the locally made and ground material, No. 4, but was inferior to that of the product obtained from the "Jigalin" nodules burnt, at the Imperial Institute, without the addition of these local solid fuels. The product set much quicker than the locally ground material either in the condition as received or after reburning at the Imperial Institute.

It appears, therefore, that no improvement in the strength of the product obtainable from the "Jigalin" can be effected by the use of the cowdung and charcoal as fuel.

Experiments were also carried out to determine whether the addition of the ash obtained from the cowdung and charcoal would have any effect upon the properties of the burnt " Jigalin."

For this purpose a quantity of the cowdung was incinerated, and a qualitative examination made of the ash. It was found to contain a very small proportion of water-soluble matter, and the water extract was only slightly alkaline. Traces of sulphate and chloride, but no carbonate, were present. The acid-soluble material, which was fairly large in amount, contained relatively considerable quantities of alumina and lime. There was a large residue insoluble in acids, apparently consisting chiefly of fine, sandy material.

The charcoal ash, which was very small in amount, was not examined.

A mixture was made of " Jigalin," burnt at 900° C., and ground to leave a residue of 13 per cent. on a 180-mesh sieve, with 5 per cent. by weight of ash from the cowdung and charcoal (4 parts of the former with 1 of the latter), but no appreciable difference was observed between the setting time and hardness of pats made with this mixture and of those made with the burnt " Jigalin " alone.

No. 6. Impure Limestone

(*a*) *Preparation of hydraulic lime.*—The results of the chemical analysis of the limestone (see page 10) show that it is unsuitable for making natural cement, but could probably be used for the production of a hydraulic building lime.

Preliminary experiments made by burning the first sample at 1,000° C. to 1,050° C., and slaking with water, gave a product which hardened very slowly when immersed in water for a period of two months.

In order to determine whether any modification of the burning procedure would give more satisfactory results, part of the limestone was burnt at 900° C. for 3 hours, while a further portion was given a preliminary burning at 900° C. for 3 hours, after which it was slaked, ground, damped and moulded into briquettes, which were dried and reburnt at 1,050° C. for 3½ hours.

2

The first portion, burnt at 900° C. only, was slaked, ground and gauged with a volume of British Standard cement-testing sand equivalent to that of the lump lime before slaking, and briquettes were made from the mixture. The second portion, burnt at 900° C. and 1,050° C., which did not require regrinding after it had been slaked, was mixed with the same proportion of sand as had been used *for the first portion.*

The results of the tensile tests made with the two products are shown below :

TABLE VIII

LIME PREPARED FROM LIMESTONE, NO 6

Tensile Strength (lb. per sq. in.)

	First portion burnt at 900° C Water used for gauging 18·5 per cent. Briquettes removed from the moulds at 3 days after gauging, left in damp air 18 days, and placed in water until the expiration of the periods after gauging stated below			Second portion, burnt at 900° C. and 1,050° C. Water used for gauging 22 per cent. Briquettes removed from the moulds at 24 hours after gauging and afterwards:					
				(a) Left in damp air until due for breaking			(b) Left in damp air for 20 days and then placed in water, where they remained until the expiration of the periods after gauging stated below.		
	28 days.	56 days	91 days.	28 days	56 days	91 days.	28 days	56 days.	91 days.
Mean of six results .	15	30	37	56	81	85	37	67	98

The sand-cement mortar made from the limestone burnt at 900° C. set in about 48 hours, while that made from the twice-burnt material set in a few minutes.

The results show that a much stronger product was obtained by reburning the limestone as described, but the material would require an intermediate grinding after burning at 900° C. The highest strength obtained, however, was not much greater than that given by a good-quality lime of the feebly hydraulic class, such as an English grey stone lime, when tested under similar conditions.

(*b*) *Preparation of Portland cement from Limestone, No. 6, and "Jigalin," No.* 3. A small trial burning was made of a mixture of 1 part of the first sample of "Jigalin"

with 1·12 parts of the first sample of limestone, No. 6. The clinker produced by firing this mixture was ground with the addition of about 3½ per cent. of plaster of Paris, the latter being added with the object of lengthening the setting time of the cement.

It may be observed that freshly ground cement clinker produced in a gas-fired or rotary kiln is usually quick-setting in character, but provided the materials are of suitable composition the setting time can usually be modified by such means as weathering the clinker in the open air ; quenching with water as it is drawn from the kiln ; or steaming the cement during the grinding of the clinker. As an alternative or additional treatment the grinding of some gypsum or plaster of Paris with the clinker may be found necessary.

The resulting cement was hard and sound, with an initial setting time of about 10 minutes, but it would not comply with any European or American Standard Specification on account of its high percentage (5·64) of magnesia.

Further experiments were carried out with the second series of samples of these materials, but since the composition of the second sample of "Jigalin" differed in many respects from that of the material first forwarded, while the composition of the second sample of limestone approximated closely to that of the first, the proportions in which they were mixed differed from those employed in the first trials, described above.

In the initial experiments with the second samples, the limestone was mixed with the "Jigalin" in the proportion of 2·14 parts by weight of the former to one of the latter. The materials were then ground to leave a residue of 6·4 per cent. on a sieve having 180 meshes per linear inch and were mixed with water and moulded into a convenient form for burning.

The clinker produced by burning the mixture was quenched with water, ground to leave a residue of 5 per cent. on a sieve having 170 meshes per linear inch, and only a trace of residue when sifted on one having 72 meshes per linear inch ; 2 per cent. of finely ground plaster of Paris was then added and the sample tested in accord-

ance with the British Standard Specification for Portland Cement, 1931. The results complied with the requirements of the Specification in every respect and showed that a Portland cement of excellent quality could be obtained by using an appropriate mixture of these materials. The tensile strength was much in excess of the Specification requirements; that of the neat cement at 7 days being 1,153 lb. per sq. in. and of the 3 : 1 sand-cement mortar at 3 and 7 days, 357 lb. and 475 lb. per sq. in. respectively.

A second burning was made of the raw materials mixed in the same proportion and ground, before burning, to leave a residue of 6 per cent. on a sieve having 180 meshes per linear inch. Special attention was given to control of the setting time and with this object in view the clinker was burnt for a rather longer period than on the previous occasion, and it was allowed to cool to a lower temperature before being quenched. Two per cent. of finely powdered plaster of Paris was added to the clinker after grinding. The results of the tensile tests on the second sample of cement produced in this way from the materials confirm the opinion as to the high quality of the cement obtainable. The initial setting time was more prolonged than that of the cement produced in the first burning, in which it was only 38 minutes. The full results of the tests on this cement, which comply with the requirements of the British Standard Specification 1931, are shown in Table IX.

No. 9. Mud

The composition of this mud, as shown in Table I, indicates that it is unsuitable for use for Portland cement manufacture in conjunction with limestone, No. 6, as the ratio of silica to alumina is too high, and the amount of silica is excessive. Another sample, Clay "A," was forwarded to replace this unsatisfactory material, and the tests carried out with this clay in conjunction with limestone, No. 6, are described below.

Clay "A"

This clay, sent for trial in place of the highly siliceous mud, No. 9, contained less than 1 per cent. of sand retained on a sieve having 100 meshes per linear inch.

TABLE IX

PORTLAND CEMENT MADE FROM LIMESTONE, NO. 6, AND "JIGALIN," NO. 3

Chemical Analysis

		Per cent.
Silica	SiO_2	21·42
Insoluble residue		0·93
Ferric oxide	Fe_2O_3	3·26
Alumina	Al_2O_3	6·07
Lime	CaO	64·10
Magnesia	MgO	1·41
Total sulphur expressed as sulphuric anhydride	SO_3	1·03
Loss on ignition		1·74

$$\frac{CaO\ (equiv.)}{SiO_2(equiv.) + Al_2O_3(equiv.)} \quad 2{\cdot}72$$

Fineness

	Per cent.
Residue on sieve of British Standard Mesh No. 170	4·0
Residue on sieve of British Standard Mesh No 72	0·8

Setting Time

Initial: 1 hour.
Final: 1 hour 55 minutes
Water used for gauging, 17·4 per cent.

Tensile Strength
(lb. per sq in)

Cement with 3 parts of standard sand.		Optional neat cement test.
At 3 days.	*At 7 days*	*At 7 days.*
390	455	1,250
390	465	1,240
380	445	1,240
385	455	1,225
380	435	1,240
420	470	1,200
Mean 391	454	1,233
Water used for gauging, 6·85 per cent		Water used for gauging, 17·4 per cent.

Soundness

Expansion in Le Chatelier apparatus: On unaerated cement—nil.

For the production of an artificial Portland cement it was used in admixture with limestone, No. 6, in the proportion of 9 parts of limestone to 1 of clay. The cement

obtained was extremely quick-setting and although the clinker was quenched with water, and 2 per cent. of plaster of Paris added after grinding, the setting time remained unaltered. The cement was then submitted to a current of steam, but though the setting time was more prolonged after this treatment, it remained too quick to comply with the requirements of the British Standard Specification, 1931, and the strength of the cement, while exceeding that required by the Specification, was much below that anticipated, the average strength of six briquettes of neat cement at 7 days after gauging being 838 lb. per sq. in. while that of the 3 and 7 days 3 : 1 sand-cement mortar briquettes was 308 and 401 lb. per sq. in. respectively. The cement-mortar thus only just complied with the Specification in respect of its tensile strength at the shorter period.

A second trial was made with these materials, which were mixed in the same proportion as before, and ground to leave a residue of 8·7 per cent. on a sieve having 180 meshes per linear inch, and no residue when sifted on a 100-mesh sieve. After mixing with water and moulding into convenient form, the material was dried and burned in a gas-fired furnace, the clinker produced being quenched with water, ground and mixed with 2 per cent. of finely-ground plaster of Paris. The results of the tests upon this cement, made in accordance with the British Standard Specification for Portland Cement, 1931, are given in Table X, and show that the cement complies with the Specification in every respect. It will be seen that much more satisfactory results were obtained in the second burning, and that the initial setting time of the cement was considerably prolonged.

The mixture of clay "A" and limestone, No. 6, would be dealt with more easily under manufacturing conditions than would the mixture of "Jigalin" and limestone, since, on account of the small quantity of coarse sand in the clay, much less grinding of the raw materials would be necessary. The clay is also readily broken down by water, which might be found an advantage if the manufacture of Portland cement from the clay, in conjunction with a calcareous material suitable for treatment by the wet or

TABLE X

PORTLAND CEMENT MADE FROM LIMESTONE, NO. 6, AND CLAY "A"

Chemical Analysis

		Per cent.
Silica	SiO_2	19·30
Insoluble residue		0·75
Ferric oxide	Fe_2O_3	3·91
Alumina	Al_2O_3	7·45
Lime	CaO	63·67
Magnesia	MgO	1·26
Total sulphur expressed as sulphuric anhydride	SO_3	1·04
Loss on ignition		2·59

$$\frac{CaO(\text{equiv.})}{SiO_2(\text{equiv.}) + Al_2O_3(\text{equiv.})} = 2{\cdot}85$$

Fineness

	Per cent.
Residue on sieve of British Standard Mesh No 170	6 5
Residue on sieve of British Standard Mesh No 72	0 5

Setting Time

Initial 2 hours 35 minutes
Final 6 hours 40 minutes

Water used for gauging, 16 6 per cent

Tensile Strength
(lb per sq in)

Cement with 3 parts of standard sand		Optional neat cement test
At 3 days	*At 7 days*	*At 7 days*
340	410	1,175
365	425	1,150
340	425	1,200
340	440	1,200
320	410	1,200
365	475	1,170
Mean 345	431	1,185
Water used for gauging, 6 65 per cent		Water used for gauging, 16 6 per cent.

Soundness

Expansion in Le Chatelier apparatus. On unaerated cement—2 mm.

semi-wet process, is at any time contemplated. The deposit of clay may also prove to be more uniform in composition than that of the "Jigalin."

No. 10. *Calcareous Material*

After burning this material at 1,000° C., the product slaked slowly and required grinding before use. The quantity available was small, but a few briquettes were made from the lime in admixture with a volume of British Standard cement-testing sand equivalent to that of the lump lime before slaking. The water used for gauging amounted to 19·5 per cent. of the mixture. The briquettes hardened slowly, and were removed from the moulds at 3 days after gauging, and were then left in damp air for a further 18 days before being placed in water, where they remained until they were tested at 28, 56 and 91 days from the date of gauging. The results obtained are shown below:

TABLE XI

LIME PREPARED FROM CALCAREOUS MATERIAL, NO. 10

Tensile Strength (lb. per sq. in.)

	28 days.	56 days.	91 days.
Mean of three results .	30	62	92

The above results show that the strength of the product was slightly higher than that usually given by a good-quality lime of the feebly hydraulic type. The product in this case is superior in strength to that obtained from a single burning of limestone, No 6.

Limestone " B "

The analysis of this calcareous sample agrees so closely with that of No. 10 that it appears likely that the deposit of this material is more uniform in composition than is the " Jigalin," and could probably be used instead of that material for combination with limestone, No. 6. The silica in " B," moreover, appears to be in a much finer condition than that in the " Jigalin."

A trial burning of a mixture consisting of 2·9 parts by weight of limestone, No. 6, to 1 of " B " was made, but it was found that the mixture was very difficult to burn owing to its high softening point, and the clinker obtained also tended to disintegrate when drawn from the furnace. A pat made from the cement produced was, however, quite

sound and hard and, apart from its extremely quick-setting nature, showed all the properties of a cement of good quality.

The high softening point of the clinker mentioned above could be lowered by adding a small proportion of Bornu ironstone "C" to the raw mixture. By using 58 parts by weight of limestone No. 6 with 19 parts of limestone "B" and 1 part of "C" the mixture was found to be much easier to burn, and the cement produced from the clinker was sound on boiling and of good strength, so far as could be judged from the boiling pat. Any physical tests were impossible owing to sufficient material not being available.

Sample "C." Bornu Ironstone

The iron, or ferro-Portland, cements vary widely in composition, but usually they contain at least as much iron oxide as alumina, the ratio varying between 1 : 1 and 4 : 1, and the amount of silica is rather low. They are characterised by their slow hardening properties (unless gypsum or plaster of Paris has been added to the cement) and also by their relative immunity to the action of sea and alkaline waters, and for this reason they have found favour in marine construction.

As a component of a raw mixture for the manufacture of cement of the iron-Portland type, Bornu ironstone "C" is not suitable for use in combination with limestone No. 6 alone, as it is deficient in silica. A mixture of two components only, utilising this iron ore, would need a more highly siliceous limestone than that represented by No. 6.

A preliminary burning was made of a three-component mixture composed of about 8·3 parts by weight of limestone No. 6 with 2 parts of "Jigalin" No. 3 (second sample) to 1 part of "C." The cement made from this mixture by burning, quenching and grinding the clinker, and mixing the product with 2 per cent. of gypsum, set in about 20 minutes. It hardened slowly and was constant in volume, as shown by the boiling test.

A further quantity of the mixture detailed above, after moulding into a suitable form with water, was dried and

burnt in a gas-fired furnace and then ground to cement of such fineness that a residue of 5·8 per cent. was left on a sieve having 170 meshes per linear inch, and 0·1 per cent. on one having 72 meshes per inch.

The analysis of the cement was as follows :

TABLE XII

IRON-PORTLAND CEMENT MADE FROM BORNU IRONSTONE, "C," LIMESTONE, NO. 6, AND "JIGALIN"

		Per cent.
Insoluble residue		0·87
Silica	SiO_2	19·12
Alumina	Al_2O_3	5·49
Ferric oxide	Fe_2O_3	10·62
Lime	CaO	59·24
Magnesia	MgO	1·37
Sulphuric anhydride	SO_3	1·15
Loss on ignition		1·88

The cement had an initial setting time of 22 minutes and a final setting time of 33 minutes, upon the length of which none of the recognised methods of control appeared to exercise any modification. Preliminary experiments showed that the cement hardened slowly even with the addition of gypsum or plaster of Paris, the effect of which is normally to act as an accelerator of the hardening process rather than as a retarder of the setting time of this type of cement. It was constant in volume, showing no expansion when submitted to the Le Chatelier soundness test. The tensile strength of the neat cement when gauged with 17·5 per cent. of water was 753 lb. per sq. in. after storage of the briquettes for 24 hours in damp air followed by 6 days in water, while the tensile strength of a 3 : 1 sand-cement mortar was 271 lb. per sq. in. 3 days from gauging (24 hours' storage in moist air and 2 days in water), and 373 lb. per sq. in. 7 days from gauging (24 hours in moist air and 6 days in water). The rate of hardening between the 3- and 7-day periods was quite satisfactory.

Tensile strengths of 688 lb. per sq. in. for the 7 days' neat test and 195 lb. per sq. in. for a 7-day 3 : 1 sand-cement mortar, with both of which the present results compare very favourably, have been recorded for iron-Portland cements of this type. It is possible that the use of material represented by Sample "B" would be prefer-

able to that of " Jigalin " in this mixture, since, as already mentioned, the free silica in the former material is in a more finely divided condition than in the latter, and the total silica is rather larger in amount, but the quantity of " B " available was too small to allow of further experiment.

Summary

The results obtained with the samples of " Jigalin " nodules indicate that natural cement produced from it is weak in character, its strength being much below the average for cements of this type.

The product, obtained by burning the nodules at 900° C., was approximately of the same strength, when tested neat, as the ground material prepared in Nigeria, but when mixed with sand was superior in tensile strength to corresponding mixtures of sand with that material.

Limestone, No. 6, when burnt under the most favourable conditions, yielded a product possessing strength slightly greater than that of a feebly hydraulic lime, but a similar product could be more readily obtained from the calcareous material, No. 10.

Portland cements have been produced from limestone, No. 6, used in admixture with :

(*a*) " Jigalin " nodules ;
(*b*) Clay sample " A " ;
(*c*) A mixture of limestone " B " and ironstone " C."

The cements produced from mixtures (*a*) and (*b*) have been shown to comply easily with the requirements of the British Standard Specification for Portland Cement, 1931. Cement made from mixture (*c*) would probably also comply with the Specification, but it would involve the use of three components in the raw mixture and in view of the excellent results obtained with mixtures (*a*) and (*b*), the use of (*c*) for this purpose is not advised.

A type of ferro-Portland cement has been produced from a mixture of limestone, No. 6, " Jigalin," No. 3, and ironstone, " C," which showed excellent properties as regards tensile strength, but was of a very quick setting character. It is probable, moreover, that the local manufacture of such a product, involving as it does the use of

three constituents in the raw mixture, would not be advisable, except for special purposes, in view of the fact that ordinary Portland cement of superior strength can be made from simpler combinations of other materials available.

If, however, there is sufficient local demand for a cement possessing the special characteristics of the iron-Portland type, a simplification in its manufacture could be effected by the use of a two-component mixture consisting either of limestone, No. 6, in conjunction with an appropriate iron ore (more siliceous than that represented by Sample "C"), or of Sample "C" with a limestone more siliceous than No. 6.

ARTICLES

EMPIRE FIBRES FOR MARINE CORDAGE

Tests of Cordage Manufactured from Manila and Sisal Hemps

REPORT OF TRIALS CARRIED OUT BY THE ADMIRALTY

The following report, prepared by the Admiralty, has been kindly furnished to the Imperial Institute and is now published for general information.

1. In order to encourage the use of Empire fibres for the manufacture of marine cordage, tests were commenced in 1926 in conjunction with the Imperial Institute Advisory Committee on Vegetable Fibres to ascertain the degree to which ropes manufactured from Empire hemp could resist the action of sea-water as compared with ropes made from Manila. Reports on the investigations conducted at the Imperial Institute were published in three reports in the Bulletin of the Imperial Institute (1927, **25**, 359–368; 1931, **29**, 1–31; 1932, **30**, 119–124).

2. **Preliminary Exposure Tests.**—The initial Admiralty report on Sisal was printed as an Appendix to the second of the above-mentioned reports (1931, **29**, 31–34) and it was as follows.

"Concurrently with the tests carried out by the Imperial Institute and described in the foregoing report, the

Admiralty also conducted a series of independent trials on similar lines. The ropes used in these trials were manufactured by the Admiralty from: (*a*) Manila J. Grade and (*b*) British East African Brushed Sisal, First Quality, and were exposed to the action of sea-water at Sheerness and Devonport.

"The results of these exposure tests, which were carried out under similar conditions to those employed in the Imperial Institute tests, were reported by the Admiralty as follows.

"'*Sea Exposure Tests.*—Over a six months' exposure period, the Sisal compared very closely with the Manila. In the final stages of the twelve months' trials the Manila gave the best results. Generally, however, the Sisal fibre can be regarded as satisfactory so far as its capacity to resist the action of sea-water is concerned.'

"A further series of exposure tests was also planned with a view to imitating service conditions more closely. In this series a portion of each of the ropes was removed from the sea at Devonport at the end of six months' sea exposure and was wound closely round drums in a wet condition. Some of the drums were then exposed to weather conditions and others retained under cover in the Ropery. The Report on these tests was as follows.

"'*Exposure on drums after removal from sea-water.*—The Sisal withstood the conditions of this test over the five months' period of exposure equally as well as the Manila.'

"The results of these tests are summarised by the Admiralty as follows.

"'*British East African Brushed Sisal—No.* 1 *Quality.*—(*a*) Much better appearance than Manila owing to the light colour of the fibre.

(*b*) Higher initial breaking strain than Manila.

(*c*) Capable of withstanding the action of sea-water over a prolonged period.

(*d*) Compares favourably with Manila when exposed under service conditions.

(*e*) When immersed in sea-water, Sisal compared with Manila :

(i) Absorbs water at a much quicker rate and sinks more rapidly.

(ii) Swells more.

(iii) Shrinks in length at a quicker rate.

(iv) Does not return to its original size when dry, but remains in its expanded state, whereas Manila gradually returns to its approximate original size.' "

3. **Preliminary Service Tests.**—On conclusion of the exposure tests the balance of the Sisal Cordage was issued to certain of H.M. Ships for small-scale trial under service conditions. This cordage was used for boats' falls and during the trial period it was subject to exceptionally wet weather. The falls satisfactorily completed the normal period of service. The results indicated that the Sisal was as strong as Manila and more pliable. It compared favourably with Manila as regards its capacity to withstand the action of sea-water and no trouble was experienced as regards swelling.

4. **Large-scale Trials.**—In view of the favourable initial report it was decided to carry out trials on a large scale. Fifty tons of No. 1 British East African Sisal were purchased in February 1931 and made into hawserlaid cordage.

The yarn was made up into coils of ⅝ in. to 5 in. circumference. The coils were each 120 fathoms in length, and the total manufacture amounted to approximately 1,000 coils. The cordage was made in accordance with Government Departmental Specification for Manila Ropes, T.G.30, viz. :

Number of strands	3
Angle of lay	39°
Size of yarn ⅝ in. and ¾ in.	40
1 in. to 3 in.	30
3½ in. to 5 in.	25

The East African Brushed Sisal used for the trials was grown on a coastal estate, and it was passed through the usual scutching and drawing processes before being spun into yarn. No difficulties of any sort were experienced,

and the loss of fibre in the course of manufacture into yarn did not exceed 1 per cent. The fibre was not adulterated in any way, and no weighting of any description was used apart from the addition of mineral oil to the extent of 9 to 10 per cent. The oil used is a special mineral lubrication oil which has been used and returned as unsuitable for further lubricating service.

Weight of finished coils was easily within the tolerances laid down.

Yarn Tests.—Samples taken from portions of the finished cordage gave the following results in pounds.

	40 thread.						30 thread.					
	125	115	145	145	105	105	205	185	175	175	140	195
	105	95	115	130	135	135	220	205	190	150	155	215
	115	130	135	135	115	135	195	240	205	185	170	160
	95	145	105	140	140	110	255	195	160	190	205	185
	105	115	115	130	140	125	210	215	185	205	190	190
	115	115	115	125	100	120	235	235	215	215	165	210
	130	125	100	135	110	135	160	200	215	190	200	150
	125	90	105	140	95	120	175	190	170	195	185	195
	140	105	115	140	115	115	190	185	185	160	190	205
	115	120	115	135	105	100	195	205	185	175	205	170
Average	117	115½	116½	135½	115	120	204	205½	188½	184	180½	187½
	Specified breaking load . 100						Specified breaking load . 155					

	25 thread.					
	285	270	265	295	255	255
	300	265	280	270	275	270
	290	265	295	275	260	265
	275	260	270	245	285	290
	280	265	275	230	280	285
	275	255	295	265	295	275
	250	270	265	270	275	275
	255	260	245	285	270	290
	255	265	270	270	285	280
	265	235	275	270	290	275
Average	273	261	273½	267½	277	276
	Specified breaking load . 190					

These tests were carried out on a Goodbrand machine of 800 lb. capacity installed in 1931. The test lengths were each 30 in. between the points of security.

Breaking loads obtained from the cordage before issue were as follows :

Circumference.	Standard. cwts.	Actual. cwts.	Average. cwts.
½	3¾	4, 4	4
¾	7½	9, 8, 9, 8	8·5
1	10	10, 15, 13, 13, 12, 14, 13, 13	12·9
1¼	14	17, 16, 16, 18, 18	17
1½	20	21, 25, 23, 35, 27, 28, 29, 29	28·4
2	35	46, 36, 41, 37, 47, 49, 43, 40, 50, 44, 52, 52	44·75
2½	55	72, 68, 75, 74, 71, 72, 69, 67, 63, 60	69·1
3	80	89, 88, 88, 101, 104, 91, 92, 99, 100, 96, 83	93·7
3½	105	116, 118, 129, 134	124·25
4	135	138, 144, 160	147·3
4½	170	196, 174	185
5	205	246, 249, 244	246·3

The tests were carried out on a Cordage Testing Machine manufactured by Messrs. Samuel Denison & Son, Ltd., Leeds, 30 tons capacity, installed in 1930. The samples tested measured 6 ft. between the points of security.

5. **Cordage.**—Services for which used.—The cordage was issued to the Royal Dockyards and to vessels in the Africa, America and West Indies, Home and Mediterranean Fleets. It was used generally in substitution for Manila or soft hemp tarred cordage, and in particular for use as boats' falls. When the cordage was issued, instructions were given that it was to be subject to close examination during its use, especially as regards its flexibility, ease of handling and elongation compared with Manila, and for any difficulties arising from swelling or mildew.

The services for which the cordage was used during the trials may be classified as follows :

(*a*) Boats' falls in selected vessels.

(*b*) Towing hawsers, heaving and hauling lines, etc.

(*c*) Other services exposed to weather conditions—e.g. purchases, awning and side-screen lacings and fittings, boats' rigging, guard-rail lanyards, derrick tackle and guys, pole and signal halyards, breast ropes, etc., etc.

6. **Three-inch Sisal Boats' Falls.**—The usual practice for Naval requirements is for all boats' falls to be made from tarred soft hemp, whereas in the Mercantile practice

hard fibre cordage is generally used. The important difference between Naval vessels and those in the Mercantile Marine, is that the ships' boats, and therefore the falls, are more frequently used, and under all sorts of weather conditions. A further governing feature is the size of blocks and their arrangement. This introduces appreciable rope-bending stresses at the sheaves, the combined result being unavoidably severe service conditions with a shortening in the life of the rope.

In recent years trials have been carried out in H.M. Naval Service to ascertain how Manila compared with the soft hemp tarred cordage for boats' falls and generally the results have been unfavourable to Manila.

The tests with Sisal boats' falls are regarded as less favourable than Manila, the objectionable features being :

(*a*) Stretches abnormally when load is on with tendency to unlay and become long jawed.

(*b*) Marked tendency to render around the staghorn or cleat, and extra turn is necessary when lowering, particularly when wet.

(*c*) Chafes easily and precautions are necessary to ensure that it does not come into contact with anything, particularly when load is on.

In one vessel on the America Station after the falls had given satisfactory services for 6½ months and appeared in good condition, one fall parted when whaler was being hoisted. The falls were being subjected to a straight pull and they were not foul of any obstacle. During the seven days previous to the parting of the fall, the falls were soaked through with sea-water and continuous rain and fog prevented their drying. After examination the fibre was found to be brittle and rotten and gave breaking strains of 40 and 38 cwts. It is possible the fracture may have been caused by some destroying agent, although no evidence apart from the poor condition of the fibre is available to support this.

In another case on the same station it was reported that the falls stretched considerably and it became necessary to cut out the standing part and resplice on two occasions.

Apart from the foregoing a number of reports of satisfactory service were received. Samples of the worn falls were returned and subjected to tensile tests, and the average breaking strain, omitting the case of the broken fall referred to above, was 71½ cwts. It was reported upon favourably as regards its flexibility and ease of handling—apart from the care necessary when lowering—and no defects arose from mildew.

In view of the importance of this service and the severe conditions imposed, *it is not proposed to use Sisal for boats' falls* until further experience has been gained on services of lesser importance.

7. **Sisal towing hawsers, heaving and hauling lines.**—Generally the reports were satisfactory, particularly as regards flexibility and ease of handling, especially when wet. In many cases Sisal was reported as being more suitable than Manila. It stretches under load, but not to any appreciable extent, except in one instance when used for towing it was reported to stretch considerably.

Although it absorbs water quicker and fails to float for any appreciable period when payed out in a dry condition, this was not regarded as an objectionable feature. In this connection, it is noted from a report presented to the Imperial Institute Advisory Committee on Vegetable Fibres, and subsequently published in the BULLETIN OF THE IMPERIAL INSTITUTE (1932, **30**, 408), that during an immersion trial covering a period of 167 hours, 3-in. Manila actually absorbed more water than Sisal and that it was only in the initial stages of the trial that the Sisal was at a disadvantage in this respect. As regards swelling, it is also noted that Sisal assumed its maximum circumference of 3¼ in. at the end of two hours and then remained constant, whereas the Manila was 3⅛ in. at the end of two hours and subsequently increased to 3⅜ in. This may account for the fact that in the Admiralty service tests, the swelling and absorption were not unfavourably reported upon.

One case was reported of the parting of a length of Sisal, which was being used as a dinghy's painter, while the boat was lying at the boom in a moderate sea. Another report stated that it was found unsatisfactory

for use as a painter owing to its stiffness and difficulty in handling.

8. **Sisal used for other services exposed to weather conditions.**—As indicated at (*c*) in para. 5.

A large number of satisfactory reports on the use of Sisal for general purposes were received. Generally, as regards flexibility and ease of handling, it was considered to be up to the standard of Manila, and except in a few instances no difficulty was experienced as regards swelling. In some cases, when used for tackles, noticeable stretching was reported, and, when wet, it is inclined to become slippery and needs care in handling.

9. **General Summary.**—The tests covered a wide range, and over 100 ships and services participated. The only instances of actual parting of the cordage during use were :

I. Boats' falls after 6½ months' use, as referred to in para. 6.

II. Dinghy painter, as referred to in para. 7.

III. 1½-in. cordage used for standing topping lift, and running gear in a gig.

IV. 3-in. cordage used for guy purchase. In this case one strand was found damaged with what was apparently a cut. Purchase was turned end for end when another strand was found similarly damaged. It was considered these strands had not been cut, but that it was a peculiarity of Sisal to fracture in this manner.

It is not safe to assume definitely the above defects were due to inferior fibre. Sisal, like other hemps, is susceptible to contamination from outside sources—e.g. contact with acid, bad storage conditions, etc. No evidence, however, is available that the cordage was influenced by these conditions.

Another reported defect which was given prominence is powdering between the strands, leaving a residue which forms around the sheaves. This defect was only reported by two vessels, and it could be caused by overheating of the cordage before being put into use.

It was also reported that Sisal shows a tendency to

chafe, fray, become "whiskery" and "hairy" and discolour, and in this condition did not enhance the smart appearance of a ship. These reports were isolated, and they may have been contributed to by the Sisal having been kept in use beyond what may be regarded as its normal life.

The following defects can, however, be definitely regarded as peculiar to marine cordage made from Sisal.

I. Shrinks in length when wet and requires tending continually in wet weather.

II. Swells when wet, although, except in two or three isolated cases, it was insufficient to interfere with its working through blocks.

III. Elongates considerably under load, particularly when wet, and in some cases becomes definitely long jawed. Under some conditions it tends to return to size after load is removed, but generally the extension is more or less permanent.

IV. Becomes greasy and slippery, is difficult to handle when wet, and greater care is necessary when working it round a cleat or bollard.

V. After prolonged use it tends to chafe and fray and becomes discoloured.

10. **Recommendations.**—In considering the results of the trials, the question of Sisal being an Empire product must be given prominence. If the two fibres—Sisal and Manila—were on an equal footing as regards their origin, the results of the trials would not warrant any departure from the existing practice. As, however, the policy of the Admiralty is to give a preference to products of the Empire, the results are regarded as sufficiently promising to warrant the partial adoption of Sisal, and (so long as supplies of Sisal can be obtained at satisfactory prices) arrangements are being made for 50 per cent. of the Service requirements for towing hawsers, heaving and hauling lines to be made from Sisal, also for its entire adoption in the manufacture of cordage for the following services :

Side screen martingales.
" " outhauls.
" " topping lifts.
" " inhauls.
" " tackles.
Hemp hook ropes.
Coaling whip outhauls.
Dressing line whips (tailing).
Sounding spar outhauls.
Anchor buoy ropes.
Collision mat lowering lines.
Nose and tail lines for torpedoes.
Awning lacings.
Heavy lines for boats' ropes.
Creeper ropes.
Awning ear-rings.
Coaling whip downhauls.
Dressing line downhauls.
Sounding spar martingales.
" " topping lifts.
Compressor falls.
Guest ropes.
Burton falls.
Provision tackles.
Lacings for canvas fixtures, small awnings, blast screens, side screens, windsails, boats' covers, canopies, tarpaulins, etc.

The users will be informed of the known characteristics of Sisal and the precautions necessary when using same, and if Sisal continues to give satisfactory service the question of its more general adoption will receive consideration.

THE MORE IMPORTANT INSECT PESTS OF CACAO, TOBACCO AND DRIED FRUIT

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Introduction

This paper is intended to help the " practical man " to identify the most common insects which attack cacao, tobacco and dried fruit.

It is not meant to be an exhaustive treatise on the pests concerned, and the entomologist is referred elsewhere for detailed descriptions of, and keys to, the different species.

It must be realised from the start that when insects attack food products, almost all their feeding—and hence almost all the damage—is done in the " grub " or larval stage. These larvæ when fully grown usually go into a resting stage or pupa, and finally emerge into the adult insect, usually a beetle or a moth.

The adult insects mate like other animals and lay very small whitish eggs, from which hatch the young " grubs " —and so the life-cycle, as it is called, is completed.

The length of time elapsing between the laying of the egg and the emergence of the adult insect varies greatly in different types of insects, and is also affected considerably by the climatic conditions. Thus a warm atmosphere will speed up growth very appreciably, while cold conditions may slow it down so much as almost to bring life to a standstill over long periods without being so extreme as to cause death. In the same way, humidity is known to be of importance; extremes of dryness are definitely unfavourable to the growth and feeding of many insects, fairly moist conditions being the most suitable. Exactly how, and to what extent, moisture or the lack of it affects stored product insects is not yet known in sufficient detail; it is probable that with a fuller knowledge of this we shall be in a much better position to organise effective control.

Cacao

Cacao is damaged mainly by two types of insects, namely, weevil and moth.

In the first-mentioned, the feeding is mostly performed by the small fat white grubs, which are the young stages of the weevil. The adult weevils, however, also bore into cacao beans to a certain extent and are thus responsible for some of the damage.

Moth injury, on the other hand, is caused entirely by the caterpillars; the adults, by reason of their long delicate mouth-parts, cannot eat solid food.

Even though the insects are not present at the time, it is easy to distinguish the damage caused by weevils from that due to " moth." A weevil-attacked bean, when broken open, is seen to be more or less full of a brown powder, which pours easily, and resembles very coarse cocoa powder. This is the " frass " or droppings produced by the feeding insects. On the other hand, a bean in which a moth caterpillar has been at work also contains frass, but it is pellet-like and is invariably stuck more or less closely together with web.

The presence or absence of this web in an infested bean is a sure test for distinguishing moth from weevil damage.

Moth damage to cacao is due largely to the activities of two species, *Ephestia elutella* Hb., the " Cacao Moth " (Fig. 1), and *Ephestia cautella* Wlk., the " Fig Moth." A third, *Corcyra cephalonica* Staint., is only occasionally found in large numbers.

Weevil injury is caused by the Anthribid beetle *Aræcerus fasciculatus* DeG. (Fig. 2).

Ephestia spp.

The two *Ephestia* moths mentioned above are practically indistinguishable when seen in a warehouse, and as their general biology is fairly similar they will be described here together.

These moths, of the family *Phycitidæ,* are small brownish-grey insects, about $\frac{5}{8}$ in. across the expanded wings, and about $\frac{1}{2}$ in. long when the wings are folded. Both size and colour are rather variable.

The fore-wings give the impression of being more or less mottled with darker colour ; the hind-wings are self-coloured with a uniform shade of light brownish-grey, and have a fringe of long scales at the edge, giving a soft outline.

For detailed descriptions of these moths and for keys to the different species of the genus, see Richards and Thomson (1932).

For purpose of identification of these two species the following is a quick method ; hold the moth between finger and thumb so as to leave the tip of the abdomen sticking out. On squeezing gently, the genital apparatus at the end of the abdomen will be extruded, showing two hand-like claspers in the case of the male, and a single blunt-pointed process in the female—the ovipositor.

Male :

Fig Moth (*E. cautella*). A small tooth, partly concealed by scales, is found on the dorsal edge of each clasper. Three tufts of thick black scales are plainly visible on the dorsal surface just in front of the claspers.

Cacao Moth (*E. elutella*). Claspers without any tooth; tufts of scales are more scanty, grey, and not so obvious.

Female:

Fig Moth (*E. cautella*). Ovipositor blunt.
Cacao Moth (*E. elutella*). Ovipositor elongated.

(In searching for the tooth on the claspers of the males, the most satisfactory method is to run a pin along the top of the clasper, when the tooth, if present, will be readily felt.)

The moths have a quick fluttering flight and tend to settle suddenly, folding their wings at once and disappearing from view.

They mate soon after emergence from the pupa, and the female starts laying eggs. These are usually laid at night and are deposited on or near the food.

The duration of life of the adults varies with the atmospheric conditions, a female, under favourable circumstances, living about 9 days. The males are slightly longer lived.

The eggs are very small, more or less oval, and pearly white in colour. The surface has a rough appearance under a strong lens. They hatch, under suitable conditions, in 4–6 days. Low temperatures, however, retard hatching considerably; thus at 15° C. (59° F.) and 75 per cent. relative humidity, the eggs take about two weeks to hatch, and produce only about 60 per cent. of the normal number of larvæ. (From experiments on eggs of *Ephestia cautella*.)

The young larvæ are able to wander for considerable distances before feeding, and hence have a good chance of finding suitable food. Experiments conducted in this laboratory upon newly hatched larvæ of *Ephestia cautella* show that they can survive a humidity as low as 30 per cent. for some days without access to food, and show further that when placed by an electric fan, in what amounts to a stiff breeze, they survive for as long a time as they do in still air of the same temperature and humidity. Further experiments are in progress to ascertain the effect upon feeding larvæ of cacao of different moisture contents.

Cacao is a very hygroscopic substance, its moisture content varying with the humidity of the air in which it is stored. It is known that *Ephestia*, and, indeed, stored product insects generally, cannot live upon food which is below a certain minimum water content. It is possible, therefore, that an atmosphere which is unfavourably dry for the breeding of *Ephestia* exerts its effect through the actual desiccation of the cacao beans as opposed to any actual reaction upon the larvæ themselves.

The young caterpillars grow to a length of about ½ in., when they cease feeding, and tend to move away in search of a sheltered spot where they can spin their cocoons in which to pupate. These cocoons are sometimes made in the cacao beans themselves, or inside—and usually at the top of—the sack, but more often, and particularly if there is a heavy infestation, the larvæ leave the sacks altogether and migrate up the walls of the warehouse, each spinning a silk thread as it goes. Some idea of the numbers of the larvæ sometimes met with is given by the firm sheets of silk web which may be found on the walls. Such a sheet of web represents the wanderings of many thousands of caterpillars.

When the cocoon has been spun, the caterpillar changes into a brown immobile pupa, or chrysalis, and remains in this stage for about ten days.

Occasionally the pupa is unprotected by the silk cocoon.

Hibernation is usually undergone inside the silk cocoon, generally as a full-grown caterpillar, sometimes as a pupa.

The time elapsing between the laying of the egg and the emergence of the moth varies with the temperature and also with the product upon which the larvæ have been feeding. *Ephestia cautella* develops on the whole more rapidly than the Cacao Moth. Speaking generally, *Ephestia elutella* can be said to have one to two generations per year in England and Germany. It is, however, almost impossible to distinguish the broods on account of the extreme variability of the length of the larval feeding stage. This is especially pronounced in the case of the Cacao Moth, where different larvæ from the same female can vary as much as 100 days in their feeding period, with

the result that any stage may be found in a warehouse at any time in the summer months.

Both species have been found attacking a large number of foods ; these records do not necessarily represent heavy infestations, however, and the correct identification of the insects is not always certain.

Ephestia elutella has been found attacking the following products : Cacao, currants, dried grapes, dates, prunes, figs, dried apples, dried cherries, dried hips and haws, dried pomegranate root, Turkey rhubarb root, chicory, various drugs, almonds, walnuts, ground-nuts, cayenne pepper, coffee, biscuits, bread, flour and stored grain, seeds of sugar beet, tobacco, dried vegetables, nougat, leather, dead insects, etc. It is not a common pest of cereals, and is not found so frequently in dried fruit warehouses as is the Fig Moth. It is fairly common in houses, and appears to be able to maintain itself out of doors in the European climate.

Ephestia cautella is more particularly a pest of dried fruits. It has been recorded from : Currants, sultanas, raisins, dried apples, dates, pomegranates, pears, citrus fruits, asparagus berries, chocolate, tonka beans, gall-nuts, ground-nuts, chick-peas, almonds, walnuts, pecans, rice, biscuits, wheat flour, bran, maize, maize meal, hominy, oatmeal, etc.

Corcyra cephalonica

Corcyra cephalonica Staint., the Rice Moth, is also found infesting cacao, though not to the same extent as the two species of *Ephestia*. It has been found by us in cacao from ten different places. representing West Africa, South America, the West Indies and Samoa, but only in comparatively small numbers.

The damage to cacao is similar in many ways to that caused by *Ephestia* ; the pellets of frass, however, are larger owing to the greater size of the larvæ, and the cocoons are much more strongly woven, presenting a very white appearance.

It has been recorded from the following foods : Rice, currants, cacao and chocolate, ships' biscuits, maize, cotton-seed, linseed, sesame-seed, millet, ground-nuts, etc.

The adult moth is larger than the two species of *Ephestia* mentioned above, measuring from $\frac{3}{4}$ to $\frac{9}{10}$ in. across the spread wings. It is more self-coloured, the fore-wings being light buff, flecked with darker scales arranged in two rather indistinct lines running lengthwise along the wings.

Aræcerus fasciculatus

Aræcerus fasciculatus DeG., the anthribid beetle responsible for the so-called " weevil damage " to cacao, has only so far been found in numbers on cacao from West Africa. This is all the more curious, for it is a very common pest of nutmegs from the West Indies, and yet only rarely occurs on cacao from that region.

Aræcerus has been found on the following substances : Exotic fruits, maize and maize stems, strychnine, coffee, on paw-paw trees, areca, drugs, dried fruit, nutmegs, and many kinds of seeds. In a survey of cacao, spice and dried fruit warehouses in the Port of London (Munro and Thomson, 1929 ; Richards and Herford, 1930) it was shown that this insect was a serious pest only of two products, viz. cacao and nutmegs.

It has been mentioned above that *Aræcerus* is unable to withstand the rigours of the average English winter, and hence cannot, in this climate, be reckoned to be in the same category of importance as the *Ephestia* moths as a pest of stored cacao.

On the Gold Coast it is said to be primarily an outdoor insect ; it attacks the cacao on the drying trays, where it feeds largely on the mucilage adhering to the beans. Experiments now being conducted in this laboratory are indicating that the moisture content of the food has an important effect on the development of the feeding larvæ and also upon the oviposition reactions of the females. It is hoped to publish this work shortly, together with a full account of the life-history under different conditions of temperature and relative humidity.

Degree of Infestation

In a survey of West African cacao (Passmore, 1932) it was shown that about 46 per cent. of all infested beans had been damaged by moth, and about the same percentage

were weevil-attacked. The remaining small percentage were due to various other insects, which need not be considered in this article.

It appears therefore that in West Africa the moth and weevil are present in about equal numbers. This is not the case in British warehouses. The weevil is killed by the low temperatures of the average English winter and is therefore unable to build up a population from year to year. The moth, however, is more resistant, and can hibernate successfully, with the result that every year there is a large population of moths and/or caterpillars on hand ready to attack freshly imported cacao.

It is therefore obvious that as all long-period storage of cacao takes place in England as opposed to the country of origin, the moth must be considered as definitely the more important pest.

The survey showed that of all cacao imported from West Africa, a little less than 1 per cent. was attacked by insects. At first sight this seems a gratifyingly low figure, but when looked at from another view-point it is not so reassuring. It has been estimated that there are upwards of a quarter of a million beans in a sack of cacao ; 0·8 per cent. of this figure gives 2,000 infested beans introduced in each sack, of which about 900 will be moth damaged.

From these figures it will be realised that an alarming number of insects can be brought by even one small shipment of cacao, and it is easy to understand that any attempt at a radical " clean-up " of these warehouses is of little use unless a serious effort is made to introduce only clean cacao into them. This could be achieved by the use of fumigants, which constitute a most useful control measure. It should be realised, however, that fumigation is only a palliative measure and does not strike at the root of the problem. A note on fumigation methods will be found on p. 53.

To quote further from the report of the survey, it was found that the insect infestation of germinated beans was just over ten times as heavy as that of sound ungerminated material, and that broken or cracked beans were far more readily attacked than those with the shell intact.

Germination in cacao beans is the result usually of

delayed fermentation and should be largely avoidable, while a tendency to crack is normally caused by excessive drying and does not occur in a perfectly cured bean.

The preference shown by insects for germinated and cracked beans is due simply to the fact that the smooth hard shell of the bean forms a barrier which the young grubs or caterpillars find very difficult to pierce, while any hole or crack in the shell affords ready access to the nibs inside.

It can be stated with assurance that reduction in the number of cracked and germinated beans imported would cause a parallel reduction in the infestation of cacao.

Tobacco

Until comparatively recently there was considered to be only one major insect pest of cured tobacco, namely, the Cigarette Beetle (*Lasioderma serricorne*). However, another insect has enlarged its feeding range, and is now to be reckoned with as a very serious problem. This is the well-known Cacao Moth (*Ephestia elutella*).

From the scientific point of view, this apparent formation of a new food habit is of very great interest, and brings up a number of problems of considerable academic significance, which need not be considered here. On the purely practical side the fact that a widely distributed insect such as the Cacao Moth is capable of attacking a new product is obviously of serious importance.

Ephestia elutella Hb. (*the Cacao Moth*)

The biology of this insect has already been described under the section dealing with pests of cacao ; it is very similar when tobacco is being attacked.

The eggs are laid either upon exposed tobacco or upon the hessian covering of the bales. The female moth shows a decided preference for placing its eggs on flue-cured tobaccos, and avoids, for the most part, fire-cured types of leaf.

The cocoon, as in the case of cacao, may be placed in the tobacco itself, inside the cover of the bale or in cracks in the walls or ceiling of the warehouse.

Bovingdon (1931) has given an account of this moth as occurring on tobacco, and a more detailed report is shortly to be published. The following is an extract from

Bovingdon's paper concerning the type of damage caused by the Cacao Moth :

" No damage can be attributed to the adult moth, for its mouth is adapted only for sucking and it cannot feed upon solid matter. All the damage is done by the activities of the larva, which will consume almost every kind of bright flue-cured leaf, but, so far as experiment shows, will not feed upon the fire-cured types. The action of the smoke from the curing fires seems to render the tobacco poisonous to the caterpillars.

" In feeding upon the leaf packed into bales the insect avoids the large veins and forms large, irregularly shaped holes, which will be seen to advantage if the damaged leaf is laid out flat. The regularly cylindrical holes, typical of the tobacco beetle, are not found. In boxes of cigarettes the caterpillars feed upon the tobacco inside the paper coverings and, occasionally, make irregular holes in the papers themselves, and, again, these holes are quite unlike those made by the tobacco beetle.

" Almost everywhere the larva wanders it spins very fine threads of silk, which, when in mass, form a more or less dense web. Entangled with the silk are the pellets of its excrement, each of which, when the insect is feeding upon tobacco, is coloured brown at one end and light yellow at the other. These pellets are cylindrical and much larger than fine tobacco dust, and when found with the silken webbing are conclusive evidence of the presence of *Ephestia* caterpillars."

Lasioderma serricorne F. (*the Cigarette Beetle*)

This insect has perhaps as wide a range of foods as any other stored products pest. It has been recorded from : Army biscuits, bamboo, bananas (dried), belladonna, books, bread, butter beans, cacao, cane work, caraway seeds, cassava, cayenne pepper, chick-peas, cigars, cigarettes, coffee, cotton, coriander seeds, cotton bolls, cumin seeds, dates, ergot, figs, fish (dried), furniture upholstery, ginger, gun wads, herbs, herbarium specimens, liquorice, nutmegs, pumpkin seeds, pyrethrum powder, raisins, rhubarb, rice, tamarind seeds, turmeric, wheat and wheat products.

It is, however, as a pest of tobacco that this insect is most notorious. The name "Cigarette Beetle" is perhaps rather misleading, as it suggests that the insect feeds mainly upon already prepared tobaccos and is a pest of the factory as opposed to the warehouse. This is not the case, for tobacco in bulk is readily attacked, preference being shown for the better grades of cured leaf. It does not occur on tobacco in the field.

The eggs are laid on the tobacco, usually in the angle of a fold in the leaf, or along the side of the mid-rib or other large vein. They are smooth, oval and pearly white.

The number of eggs laid by each female varies greatly, the average number being about 30 ; exceptional cases have shown as many as 103.

The eggs hatch in about 8 days at 70° F., and the young larvæ on emerging burrow away from the light and begin to feed, forming, as they go, the cylindrical tunnels so typical of the work of this insect. Under suitable conditions the larval life is about 5 weeks, when the grub is fully grown. The larval period may be greatly lengthened by cold ; thus at 60° F. the grub becomes dormant and may hibernate until the return of warmer weather.

"Almost the whole of the damage is caused by the larva, which bores through the tobacco in all directions and makes long, winding tunnels, circular in section. These galleries are more or less filled with a mass of tobacco dust and minute pellets of excrement. It will even bore through the paper coverings and cork tips of cigarettes or cigars lying adjacent to one another. It will consume almost any kind of tobacco, but prefers the milder and sweeter types.

"The larva spins no web and its excrement is indistinguishable from tobacco dust. In this way it differs from the caterpillar of the Cacao Moth. The adult beetles are responsible only for the holes which they make in effecting an exit from the pupal cells" (Bovingdon, 1931).

When fully grown, the larva constructs a round cell of silk, in the walls of which tobacco dust and frass are worked, forming a tough brown covering. The insect remains about 15–20 days in this cell, undergoing the

changes from larva to pupa and from pupa to adult. At the end of this time the young adult bites its way out and emerges. Mating takes place very soon after emergence, and the female begins to lay her eggs.

The total life-cycle, egg-adult, varies greatly in length, according to conditions ; in an artificially warm and moist atmosphere, say at 27° C. and 75 per cent. relative humidity, breeding is continuous, and 5–6 annual generations may be expected. In the average English warehouse, however, it appears unlikely that more than one generation can be accomplished in the year.

Control

Control of these insects attacking tobacco in storage may be effected by fumigation or by exposure to low temperatures and before or during manufacture by the usual reconditioning process employing moist heat.

Tobacco does not lend itself to the use of other types of climatic control, such as extreme dryness or heat, for the atmospheric conditions suitable for tobacco storage, and more particularly for its manufacture, lie between fairly narrow limits, and are unfortunately such as are quite favourable for insect development.

Dried Fruit

Dried fruit has long been known to suffer from the attacks of insects, upwards of twenty different species having been found associated with this product at one time or another. Of this number, however, the majority are of negligible importance, being either refuse feeders, pests of fresh or fallen fruits rather than of dried fruits, or predators and parasites upon other insects.

Of the really harmful insects the most important are the "Indian Meal Moth," *Plodia interpunctella* Hb., "The Fig Moth," *Ephestia cautella* Wlk., and "The Cacao Moth," *Ephestia elutella* Hb. These all belong to the same family, *Phycitidæ*, and are closely related to each other.

These moths lay their eggs either on or near the fruit ; even when the eggs are on the outside of the box the young larvæ readily find their way through cracks in the wood, and at once attack the fruit, working their way inwards

PLATE I.

FIG. 1. *Ephestia elutella* Hb. The Cacao Moth. Adult at rest.

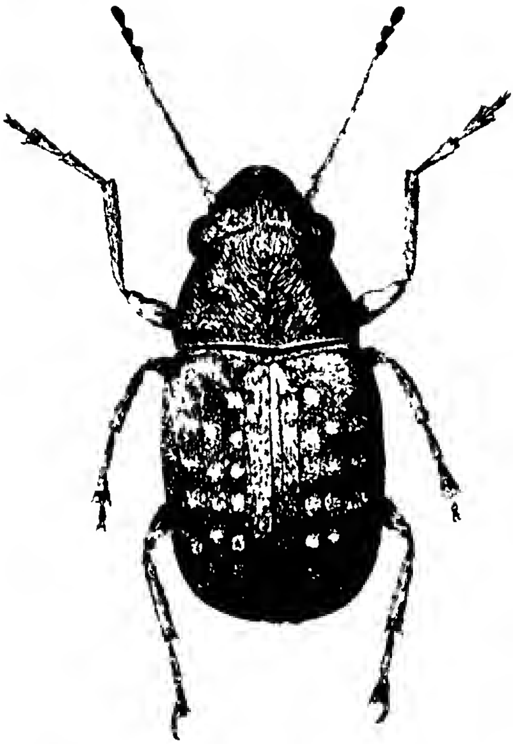

FIG. 2. *Araecerus fasciculatus* DeG. The Cacao Weevil.

FIG. 3. *Lasioderma serricorne* F.
(The Cigarette Beetle.)

until, finally, the whole mass may be riddled through. The entire feeding period is passed in the fruit. When fully grown, the caterpillars frequently leave the fruit before pupation, though in many cases—especially when the infestation is slight—the pupa may be formed inside the box. The duration of larval life varies greatly with temperature, becoming shorter under warm conditions, and vice versa. *Ephestia cautella* and *Plodia interpunctella*, reared at an average temperature of 26° C., took 70 and 35–50 days respectively for their total life-history. (*Ephestia elutella* has not been worked out in detail on dried fruit, but on other products such as cacao, the life-cycle is somewhat longer.)

The adult moths of all three species mate within a few hours after emergence from the pupa, and egg-laying usually commences during the first night after mating.

The moths *Ephestia elutella* and *E. cautella* have already been briefly described (see above, under " Cacao ") ; there should be no difficulty in distinguishing these two moths from *Plodia interpunctella*. Both species of *Ephestia* have fore-wings of a more or less uniform dull mottled grey and hind-wings of a lighter grey, whereas in *Plodia* the fore-wings are whitish for the basal third of the wing, the remainder being a bright reddish-brown, slightly shaded with grey. The hind-wings are whitish-grey.

The larvæ of *Ephestia cautella* are very difficult to separate from those of *E. elutella* without the aid of a strong lens, but both may be easily distinguished from the larvæ of *Plodia* by their pinkish colour and by the presence of small dark spots arranged in rows along the back of the caterpillar. *Plodia* larvæ are very seldom pinkish, being usually creamy white, and they do not have the rows of dark spots.

With dried fruit, as with cacao and many other products, the problem of insect infestation can only be finally solved when it is attacked from both ends, i.e. in the country of its origin and at its destination.

Of late years, certain dried fruit imported into London has suffered severely from insect damage. This was due to a number of causes ; in the first place, proper precautions were not taken to guard against infestation before

the fruit was shipped. It was not, apparently, realised that even a few moths—or a few caterpillars or eggs—could, in the course of a long warm sea voyage, produce an alarmingly heavy infestation.

Fruit arriving in London in this state had to be given some sterilising treatment, and was therefore fumigated. The process employed was, for various reasons, not always successful, and fruit was often brought into warehouses for storage still containing live insects. The natural result was that some of these warehouses became infested with a very large population of insects, which attacked not only the fruit already in store, but also newly landed and fumigated supplies.

This state of affairs was further aggravated by economic conditions which necessitated the storage of dried fruit being unduly prolonged and did not permit of the warehouses ever lying empty for long enough for a proper clean-up to be made.

Since that time conditions have improved considerably, due, in no small degree, to the advances in fumigation technique made by the chemical section of these laboratories. (See below, under separate heading.)

There are indications that a more thorough fumigation will be given to the fruit before shipping, while at this end it has become possible to fumigate successfully very large warehouses, either empty or containing fruit, and to arrange effective treatment by fumigation of any fruit which may be still infested on arrival in England.

The account given above describes more or less closely the infestation problems of many imported products, and demonstrates clearly the exceedingly valuable part that scientific fumigation can play in producing immediate alleviation. The value of such treatment is even yet not so widely realised in this country as it might be.

Anyone who has had experience of such matters will appreciate that wholesale fumigation of warehouses and freshly landed material is inevitably an arduous and costly proceeding. A great deal, and, in theory, all of this labour and expenditure might be avoided if really rigid precautions were taken to eliminate infestation before shipment of the product from the exporting country, and to ensure that

all ships carrying fruit were thoroughly fumigated before each voyage.

It is not possible at this stage to say whether the control of insects in dried fruit may ever be accomplished without the use of fumigants. It is certain that scrupulous cleanliness observed in all stages of packing and preparation helps greatly in the elimination of insect attack (Myers, 1928). Control by cold storage has not been attempted on a really large scale, and would probably not be commercially practicable, while extremes of heat or dryness, which are very useful control measures for some products, are probably to be ruled out as being harmful to the quality of the fruit.

It may be, therefore, that the most satisfactory method of insect control in this product will consist of perfect cleanliness in the drying and packing sheds, followed by efficient fumigation immediately previous to shipment. Steps must be taken to ensure that all ships carrying fruit are regularly fumigated, and all warehouses in which the fruit is to be stored on arrival should be kept clean and should be so constructed as to render fumigation possible in case of an emergency.

Fumigation

The main work of the chemical department of these laboratories is to study the scientific problems underlying fumigation, both in the laboratory and in the warehouses themselves.

One of its immediate objects is the investigation of the behaviour of the gas during an actual fumigation. For this purpose it was found necessary to devise a method for obtaining accurate samples of the gas from different parts of the chamber or warehouse, and at different times during the fumigation. Such an apparatus has been made and described (A. B. P. Page, 1932), and is giving very interesting results. In fumigation of ships, mills and warehouses, as practised commercially, it was found that no serious attempts were made to determine the behaviour of the gases used during the actual process of fumigation. Effects of low temperature—which retards vaporisation and makes the insects more resistant—were not sufficiently

allowed for ; the high absorption of fumigants by the products themselves and by such things as floors, walls, and dunnage were under-estimated and quite inadequate measures were taken to ensure proper vaporisation and distribution of the gas.

These matters are being investigated, and from actual results of work conducted on a commercial scale it may be stated that the distribution and concentration of gases in a warehouse may now be controlled with reasonable accuracy.

Until fairly recently, Hydrogen Cyanide was used in most extensive fumigations in this country, though for smaller undertakings Carbon Bisulphide and other gases were often employed. More recently, however, Ethylene Oxide, usually mixed with Carbon Dioxide and as such sold under the name of Ætox, has become increasingly popular and is now being fairly widely used.

Ethylene Oxide and Hydrogen Cyanide seem, at present, to stand ahead of other fumigants, especially when used for stored products. Both are highly toxic to insects, though Hydrogen Cyanide is the stronger in this respect ; both diffuse rapidly, and both possess remarkable powers of penetration.

One of the difficulties, already briefly referred to, which have been revealed by extensive practical fumigation in the warehouses in the Port of London during the winter months is the adverse effect of low temperature upon the vaporisation of the gas. To overcome this an electric evaporator has been devised for use with Hydrogen Cyanide, and a hot-water heater for use with Ethylene Oxide, and, although these instruments are as yet hardly out of the experimental stage, their use has led to a higher percentage kill of insects and a more uniform distribution of the gas even in very large warehouses in cold weather.

It must be remembered that fumigation of insects is a difficult matter. Insects vary very greatly in their reactions to different gases ; different kinds of insects vary in resistance to the same fumigant, and different stages of development of the same insect also show different degrees of resistance to a gas. Furthermore, insects at different rates of metabolism, or, to put it more simply, at different

degrees of activity, show striking differences in their reactions to a fumigant. The metabolic, or activity, rate may be governed by many factors, of which one of the more important is temperature. Thus insects which have been living for some time in a low temperature are far more difficult to kill than are those which have been kept warm and which are hence more active.

So important is this question of insect resistance to fumigants that one member of the staff is wholly engaged in its study.

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TANNING AND DYEING OF GOAT SKINS

NATIVE METHOD, KANO, NORTHERN NIGERIA

By W. G. Beaton

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The tanning of goat and sheep skins has been practised by the natives of Northern Nigeria since time immemorial, and like most other trades is confined to certain families, who hand down from generation to generation the art and craft of the process.

The leather may be left in the plain tanned crust or go through the further process of whitening and softening into doeskin or be dyed in a variety of colours. All these have their own local value, from the making of saddlery to the innumerable little leather-covered articles invariably found on every native's person, acting as charms against a variety of ju-jus or evil spirits. Elsewhere these tanned skins are none other than Morocco leather.

In recent years, however, it has been found that the Nigerian crust leather is of great value from the bookbinding point of view, owing to the property it has of resisting, for much longer periods than home-tanned skins, the deteriorating effect of sulphuric acid absorption which occurs in all large smoky towns.

The Tanyard.—In an open space a dozen or so wide-mouthed clay pots are seen tightly packed around with earth up to the neck (Plate II, Fig. 1). These pots are similar to the usual water-carrying ones. They are round-bottomed, about 2 ft. in diameter, and hold about 6 gallons. They are unprotected from the sun from above and the temperature of the liquors is round about 25° C. at midday. Near the group of pots, almost completely hidden by a well-trodden heap of hair, are wooden corn mortars set on their side at a slight angle up from the ground. Over these the hair and subcutaneous tissue are scraped from the skin.

A few low drying-lines are stretched across here and there, and several upright wooden mortars and pestles and some calabashes complete the stock-in-trade of the native tanner.

PLATE II

Fig. 1.—Clay Pots

Fig. 2.—Soaking Back the Skins

PLATE III

Fig. 1.—Unshaven

Fig. 2.—[illegible]

PLATE IV

Fig. 1.—Softening Skins after Tanning.

Fig. 2.—Rubbing in Yellow Dye.

PLATE V

Fig. 1. Working on Crystal Dyes

Fig. 2. Another View of Tanyard

Raw Material.—The skins to be tanned are purchased by the tanner from middlemen who buy them from butchers in the out-lying districts, and are mostly rejects from batches offered for sale to the skin-buying firms. The skins may be shade-dried or sun-dried, according to whether the district has come under the influence of the Veterinary Department or not.

Soaking.—The dried skins are soaked back in pots of plain water until quite soft, which takes about six hours. They are usually put through two changes of water (Plate II, Fig. 2).

Unhairing.—The limp wet skins are immersed in a mixture of wood ash and " Katsi "—about 6 lb. of the former to 4 lb. of the latter in 6 gallons of water. This makes a very thin cream which has to be frequently turned over, or the solids sediment out.

" Katsi " is a native preparation made as follows: The leaves and twigs of the indigo tree which have been used in the cloth-dyeing industry and have lost all their colour are removed from the pits and made into small balls and sun-dried. Over a stone fireplace a framework of cornstalks and " katsi " balls, layer upon layer, is built up, a fire lit below and the whole set alight. The " katsi " turns a whitish colour and very easily powders.

From six to ten skins are placed in one pot of ashes and "katsi" for two days and frequently turned over, after which they are taken out and the hair is removed. This mixture is used only once, a fresh batch being made up for each lot of skins. The skin is now placed over the side of a wooden mortar between the workman's knees and he scrapes the hair off with a double-handled blunt knife about 15 in. long (Plate III, Fig. 1).

Bating.—The unhaired skins are then washed in water and placed in a pot of " Koloko." This mixture consists of the pounded leaves of " gaba-gaba " (*Cissus aralioides*). Proportion unknown. The immersion lasts for 24 hours, after which any odd hairs and dirt are scraped off, and the skin thoroughly washed in water. This liquor is frequently changed, though not for each batch of skins. The temperature of the liquor in the pot on a hot sunny day at midday was 25° C.

Tanning.—The tanning material is the pods and seeds of the " Gabaruwa " (*Acacia arabica*). The dried pods are ground up in a mortar though the seeds are not crushed. About 4 lb. of these are added to about 4 gallons of water, and the immersion lasts 6 hours. The skin is then removed and well squeezed, and the flesh side is scraped in the same manner and with the same instrument as the hair side. It is replaced in the same solution of " gabaruwa " for 24 hours. It is then removed, squeezed, washed in several changes of water, and squeezed again and hung to dry on a line in the sun. When dry the skin is rubbed over with ground-nut oil (Plate III, Fig. 2). It is then worked to make it soft. A corner is wound round a pole held in both hands and the remainder is placed on the ground. The foot of the operator is placed on the skin and the skin is then drawn upwards against the pressure of the foot. The whole skin is worked over in this manner, and the result is the unfinished crust leather.

If a very white soft doeskin is required it is replaced in the " gabaruwa " solution for 24 hours after being oiled, rewashed several times, dried and worked with the pole for a long time (Plate IV, Fig. 1).

Dyeing.—The skins are usually dyed red or yellow with local vegetable dyes, green or magenta with imported dyes, or blue with a mixture of the latter two.

The oiled crust leather is soaked for a few minutes in water, placed in a mortar with a little water, and pounded well with a large wooden pestle for five minutes until quite soft.

Red.—The stalks of " Karan dafi "—Sorghum—are dried and pounded into a powder and mixed with the supernatant fluid of the ash and " katsi " mixture. Proportion not constant. The pounded skin is gently swilled through the dye for about 15 minutes and then squeezed and washed in water. A solution of " lime-water " is made up by placing four small green limes in about a pint and a half of water in a mortar and pounding the same, and removing the rinds. The dyed skin is then placed in this " lime-water " for 10-15 minutes and then washed in clean water, squeezed and dried.

Yellow.—For this colour the dried roots of a local plant,

PLATE XI

OWNERS OF LANYARD

" Gangamau " (*Curcuma longa* Scitaminæ) are powdered. The oiled skins are soaked back as described above and then spread out on a mat, a handful of the powdered root is then placed on the skin and " lime-water " poured on to the powder. The whole of the grain side is well rubbed over with this mixture for 10 minutes (Plate IV, Fig. 2). It is then folded up grain to grain for 15 minutes or so. It is afterwards unfolded and rubbed over again with a little more powder until the required tint is obtained. The skin is then washed in water, squeezed and dried on the line.

Green.—Crystals of this colour are sold by the Syrian and Arabian traders in the markets of Kano. About 2 grammes of the crystal are dissolved in lime-water, 1 pint. This solution is ladled on to the flattened skin on a mat and well rubbed in by hand, taking about 5 minutes, and the skin is then shaken and hung up to dry (Plate V, Fig. 1).

Magenta.—This colour is also obtained from a crystal dye, and used in the above-described manner, except that the lime-water is heated and while warm the crystals are added and the whole solution kept warm while being used.

Blue.—This colour is obtained by mixing the green and magenta crystals in warm lime-water.

Plate V, Fig. 2, shows another aspect of the tanyard and Plate VI is that of the owners of " premises," from whom most of the above particulars were obtained.

THE CERAMIC AND CEMENT-TESTING LABORATORIES OF THE IMPERIAL INSTITUTE

A WRITER in the technical press a few months ago stated that there is insufficient provision in this country for the testing of clays for industrial purposes, and outlined a number of tests to which he considered clays should be submitted in order to determine their suitability for the manufacture of bricks and tiles (*British Clayworker,* Aug. 1932, p. 154). In view of this statement, it seems worth while to call attention to the fact that the Imperial

Institute is well equipped for the preliminary examination of clays intended for use in the ceramic industry and has been carrying out this class of work for many years. It is thought that a short account of the facilities available and of the tests usually made on brick and tile clays may be of interest.

The ceramic investigations made at the Imperial Institute are carried out chiefly for the Governments of the Colonies and Protectorates, many of whom, owing to their lack of suitable laboratories, staff and equipment, are not able to have such work done locally.

With the rapid increase of settlement in our Colonies, the need for buildings of a permanent character has increased, and the greater number of clays received at the Institute have therefore been examined with respect to their suitability for making bricks and tiles. A large number have, however, also been tested to determine whether they were adapted for making porcelain, stoneware, earthenware or refractory goods. Sometimes, specimens of ware made locally are forwarded with samples of the clays from which they were made, and the Institute is asked to make suggestions regarding means by which superior products can be obtained.

The problems confronting the Institute in considering the possibility of the local use of Colonial clays, or in suggesting changes in the methods of manufacture employed locally, often have to be solved in ways which may differ from those which would be adopted in this country. Thus, consideration has to be given to the facts that native labour and primitive methods and kilns are often employed, that wood may be the only fuel available, and that materials such as pegmatite, felspar or china-clay, employed as a matter of course in this country, can be used only if they are available locally, as the expense of importing the finely ground materials would in most cases be too great. These difficulties often necessitate the use of simple processes, and instead of advising the employment of more or less complex mixtures of materials for, say, the production of pottery, experiments have to be carried out to determine how the clays themselves, with but little preparation, can be used to the best advantage.

The equipment available at the Institute for clay testing includes an automatic clay-washing plant, a vertical hand-power screw press for making experimental bricks and tiles, a power-driven auger machine for extruding pipes or bricks (wire cut), two forced-draught gas-fired muffle furnaces for firing test pieces, a high-temperature furnace for testing refractory clays, a potter's wheel and lathe, a jigger and jolley machine, a dryer, a parallel-face grinder for preparing specimens for compression test, and 30- and 100-ton compression machines. An optical pyrometer and a thermo-couple are used to measure temperature. A general view of a portion of the ceramic products laboratory is shown in Plate VII.

Mineralogical examinations and chemical analyses of the clays can be made if desired in the respective laboratories of the Mineral Resources Department of the Institute. Complete chemical analyses are not usually necessary in the case of clays for brick or tile making, but are essential when the manufacture of porcelain, stoneware, or earthenware is under consideration.

A clay received for examination for brick- or tile-making purposes is usually first submitted to a washing test, the amount of the residue being determined. By preliminary chemical and mineralogical tests, the nature of this residue is ascertained and the results obtained show whether calcium compounds or any harmful minerals are present, and indicate whether a chemical analysis is desirable. From these results, and a consideration of the condition of occurrence and of the plasticity and workability of the clay, it can usually be decided whether treatment such as weathering, washing or fine grinding is necessary, or whether the addition of sand or grog is likely to prove advantageous.

The vitrification range of the clay is then determined, this test involving the firing of a number of test bars at different temperatures, and the determination of the relative hardness, shrinkage and porosity of the products. The results of this test give further information regarding the necessity or otherwise for the addition of sand or grog or for treatment such as preheating, and afford some indication of the firing temperature likely to give the best results.

Consideration of the results obtained in the foregoing tests and an examination of the physical characteristics of the specimens obtained give, on the basis of past experience, an indication of the best method for the preliminary treatment of the clay and of the process of manufacture which is likely to be most suitable. If it is decided that the addition of sand or grog is necessary, mixtures containing different proportions of these substances are prepared, and their vitrification ranges again determined, information regarding the composition of the most suitable mixture and the appropriate firing temperature being thus obtained.

After these preliminary investigations, a further series of test bars and experimental bricks and tiles are made from the prepared clay or mixture considered best for use, and are fired at the temperature found most suitable, due consideration having been given to the limitations likely to be imposed by the conditions obtaining in the district from which the samples were received.

The following are the most important of the tests which are carried out at the Institute on the unfired and fired clay or mixture of clay with grog or sand :

(1) Determination of water of formation, i.e. the percentage of water, calculated on the weight of the dry clay, required to give a mass having the best working properties for use in the method of manufacture recommended.

(2) Measurement of drying and firing shrinkage.

(3) Determination of porosity of fired product, i.e. the volume of pore space expressed as a percentage volume of the whole piece.

(4) Determination of the cross-breaking stress of the unfired (air-dry) clay, and of the fired product.

(5) The compressive strength of the product after firing.

(6) Measurement of warpage caused by drying and firing.

(7) Freezing test on the fired product. This is an accelerated weathering test, and gives an indication of the manner in which the ware is likely to stand prolonged exposure to varying climatic conditions.

The results are compared with those of tests of a similar

PLATE VII

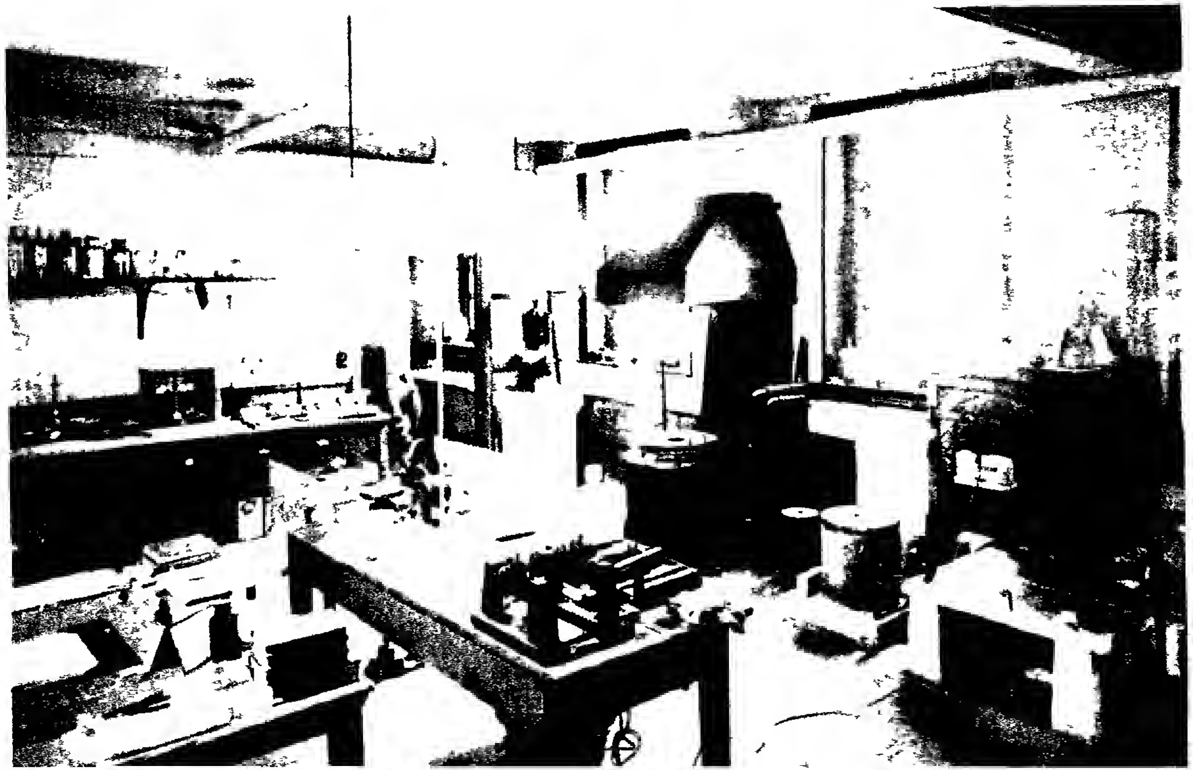
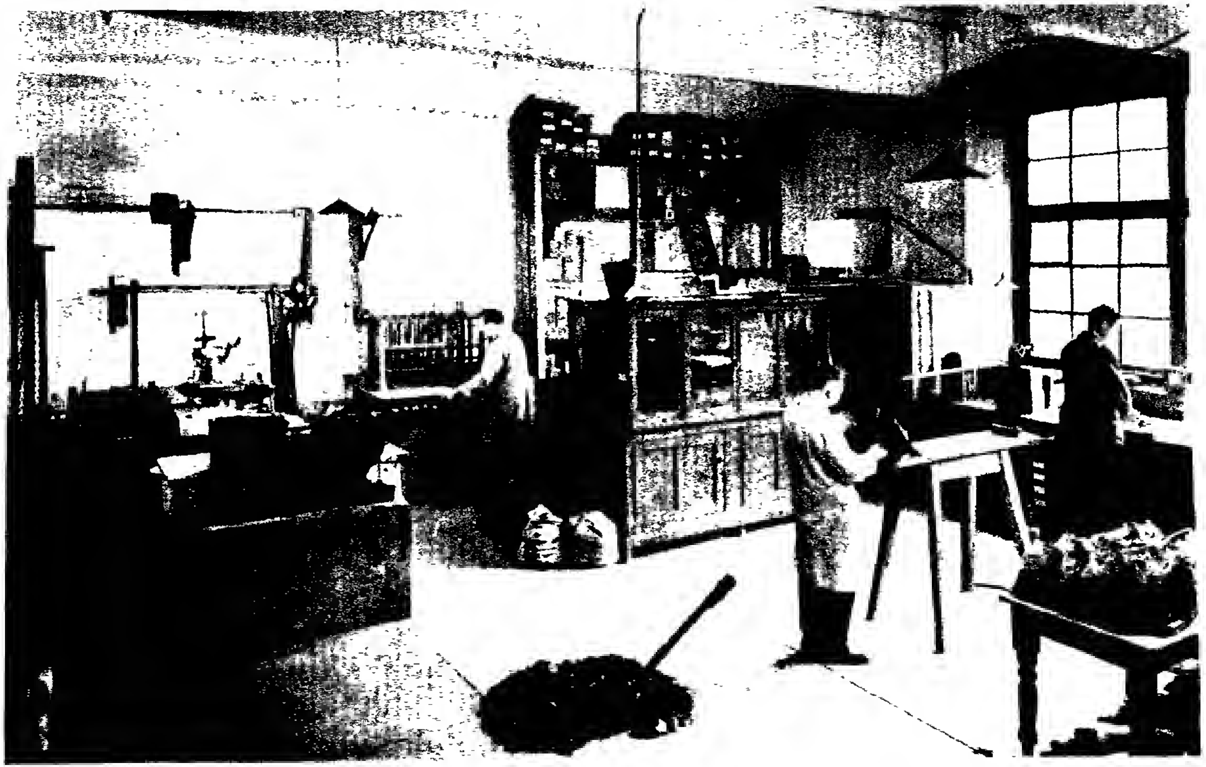


PLATE VIII



nature made with standard goods of commercial manufacture, thus enabling the quality of the experimental ware to be judged.

Another valuable branch of the technical testing work carried out at the Institute is the determination of the suitability of raw materials of various kinds for making hydraulic cement, mortar, puzzuolana or for use as aggregate in cement concrete.

In parts of the Empire remote from centres of production, the expense attached to the use of imported cement is very considerable, and many samples of limestone and other calcareous materials, shale, clay, mud, etc., have been examined at the Institute in order to ascertain their fitness for the local production of different classes of hydraulic cement. In Nyasaland, for example, the bed of a lake, 100 square miles in area, has been found, from tests made at the Imperial Institute, to contain vast amounts of calcareous mud from which Portland cement of excellent quality can be made without any treatment other than grinding and burning, and, when conditions permit, this manufacture may be established as a local industry. A full account of the tests which were made at the Institute during this investigation was given in this Bulletin (1932, **30**, 139–159).

The equipment which is available at the Institute for the testing of such raw materials includes crushing and grinding machinery, gas-fired furnaces of various types, a 100-ton compression machine for determining the compressive strength of cement or concrete cubes, and a fully equipped cement-testing laboratory containing apparatus for testing cement according to the requirements of the British and many other standard specifications. A view of one of the Institute's laboratories for testing cement-making materials is shown in Plate VIII.

The tests usually made on raw materials intended for use in the manufacture of cement include chemical analysis, the calculation, if Portland cement is to be made, of the best proportions in which they should be combined, the grinding, mixing and firing of the materials, the grinding of the clinker, and the chemical analysis and physical testing of the cement so produced.

Consideration has again to be given to local conditions, and where limitations of fuel and plant exist it is not always possible or expedient to recommend the adoption of processes which, under more favourable conditions, would give the best results with the raw materials available.

The nature and scope of the tests involved will be best seen from a consideration of the report given in the present issue of this Bulletin (p. 7) on "Cement-making Materials from Bornu Province, Nigeria."

It may be mentioned that certain foreign Governments when purchasing Portland cement require that each consignment of the material shall be certified, as regards quality, by an official testing station in the country of origin. In this connection it is interesting to note that in 1915 H.M. Government appointed the Imperial Institute to act as the authority in Great Britain to test such material and to issue the requisite certificates This work is still carried out.

NOTES

Waika Timber (*Symphonia globulifera*).—In a note on "A Survey of the Damage caused by Insects to Hardwood Timbers in Great Britain" (*Bulletin No.* 16, 1932, *Forest Products Research, Department of Scientific and Industrial Research*) which appeared in this Bulletin (1932, **30**, No. 3, 316), it was mentioned in reference to one of the timbers forming the subject of experiment that "the 'country of origin' of Waika timber (*Symphonia globulifera*) is inadvertently stated to be West Africa instead of Central America (British Honduras)."

This comment was based on the facts that Waika is a well-known secondary timber of British Honduras and that the name "Waika" is not a West African name. The Imperial Institute, however, is informed by the Forest Products Research Laboratory that the specimen of wood dealt with was in fact received from West Africa (Nigeria), where the tree *Symphonia globulifera* also occurs, and that by inadvertence the British Honduras name "Waika" was applied to the wood. It is hoped that this note will remove the impression conveyed by the comment in this Bulletin that the wood examined by the Forest Products Research Laboratory was not of West African origin.

Cocoa in São Tomé and Principe.—A *Bulletin*, bearing this title, by Leonard J. Schwarz, has recently been published by the U.S. Department of Commerce, Bureau of Foreign and Domestic Commerce, as *Trade Promotion Series No.* 138 (Washington, D.C.: Government Printing Office, 1932, price 5 cents.) The publication, in conjunction with its predecessors by the same author, viz. No. 68, *Cocoa in West Africa*, and No. 125, *Cocoa in the Ivory Coast*, affords a very good summary of information on cocoa in the world's greatest producing area. In São Tomé, as in some of the West Indian Islands, cocoa has replaced sugar; the latter crop was cultivated there before the discovery of America, whilst cocoa was introduced, "as an ornamental plant," as recently as 1822. By 1910 the production, in the two islands, had reached 36,000 tons. Wanton destruction of forests, heavy attacks by thrips and other troubles have reduced the output to some 10,000 tons. The present tendency is to a diversified agriculture, with crops such as coffee, palm oil, copra, cola and cinchona in addition to cocoa. Unlike the Gold Coast and Nigeria, the cocoa is produced on large, often very large, plantations, well equipped with roads, railway lines, good buildings, etc. The predominant type of cocoa is Forastero, a yellow Amelonado (Gold Coast type) contributing about 70 per cent., and a smooth red Trinidad type the remainder. An adequate account is given of cultivation and preparation methods, the use of shade and wind-breaks, the principal diseases and pests and of labour conditions.

World's Grain Exhibition and Conference, 1933.—Attention was called in this BULLETIN (1930, **28**, 351) to the World Grain Conference which it was proposed to hold at Regina, Canada, in 1932. Owing to the prevailing economic conditions it was decided to postpone the event and the Executive and Finance Committee now announce that the Exhibition and Conference will be held from July 24 to August 5, 1933. A pamphlet containing the final announcement and prize list has been issued and can be obtained from the Secretary, Imperial Bank Chambers, Regina, Canada, or from Canada House and British Columbia House, London, any Canadian Trade Commissioner or Government Agent, and the Secretaries of National and Provincial Committees.

At the date of publication of the final announcements, official acceptances to participate in the Exhibition and Conference had been received from about twenty different countries throughout the world. Good progress has been made by the Conference Programme Committee and so far

over thirty leading scientists, whose activities embrace all branches of field crop production and marketing, have agreed to prepare papers. It is anticipated too that a co-operative conference will take place in which the officials of the World's Co-operative Alliance are interested.

The Annual Saskatchewan Provincial Exhibition will be held concurrently with the Exhibition and Conference at Regina, whilst during July and August there will be other exhibitions in various towns in Western and Eastern Canada that can be visited.

Imperial Institute Publications on Mineral Resources: Borates.—A revised edition of the volume on *Borates* in this series has just been issued by H.M. Stationery Office, price 9*d*.

Borax and boric acid have many industrial uses and the publication of "Borates," now issued by the Imperial Institute in their series on the Mineral Resources of the British Empire and Foreign Countries, should appeal to a wide range of readers.

In accordance with the usual plan of the series, the present volume (44 pp.), after dealing with the nature, uses, production and trade in boric acid and borates, gives a detailed account of their occurrence and working.

The fall in price of borax during recent years has led to its wider use in industry.

Borax finds employment in the manufacture of glass, pottery, adhesives and paper; also in leather dressing, dyeing, enamelling and metallurgy. Its many domestic uses include that of a water softener and cleanser, and its derivative, perborate of soda, is an important bleaching agent. Manganese borate is used in the manufacture of paint, printing inks and linoleum. The mild antiseptic and detergent properties of boric acid and borax render them of value in pharmacy. So far, the demand for boron itself has been small; some borides have possibilities as abrasives and in the steel industry.

The recovery of boron compounds from natural sources, an industry of considerable antiquity, has undergone many changes during the past decade. New sources of raw material have been discovered which have necessitated changes in the methods used for refining the products.

The sources of the raw material include the Californian deposits of kernite or razorite (hydrated sodium borate) which now furnish a very large proportion of the world's requirements of crude borates, deposits of pandermite (hydrated calcium borate) in Turkey, and volcanic emanations containing boric acid in Italy. The recovery of the acid in Italy from natural steam of volcanic origin is of

considerable interest. This steam contains only one part of boric acid in 6,000 and is used not only as a commercial source of the acid, but also for the recovery of ammonia and carbon dioxide. In addition to being used for evaporation, the steam is also employed to generate electric power for the surrounding towns. Methods employed in the recovery of borates from this and other sources are briefly described in the Imperial Institute brochure, which concludes with a useful selected bibliography.

RECENT RESEARCH ON EMPIRE PRODUCTS

A Record of Work conducted by Government Technical Departments Overseas

AGRICULTURE

Soils

British Guiana.—The Institute has received from the Director the following report regarding research on soils and manures recently carried out by the Department of Agriculture.

Sugar-cane Soils.—The cultivated coastal soils of the colony consist of two main types :

(1) *The front land clay*, an acidic clay topsoil, overlying a less acidic saline clay subsoil.

(2) *The pegasse*, a highly acidic topsoil, containing considerable quantities of organic matter of wide carbon-nitrogen ratio, overlying a highly acidic clay subsoil.

The two types have been described in the Annual Report of the Chemical Division, Department of Agriculture, British Guiana, 1931. Roughly 75 per cent. of the colony's cane cultivation is supported by the more fertile front land clay.

It has been the practice in recent years to flood-fallow the discarded lands of this type for some six months before replanting. The resultant increases in crop are very marked in the plant canes, but gradually disappear with succeeding ratoon crops. Laboratory work suggests that the following factors are among those causing improvement :

(*a*) The soil content of ammonia increases consequent on waterlogging.

(*b*) Considerable quantities of toxic soluble salts are removed from the upper layers of the soil.

(c) The interaction of the flooding water, containing small amounts of lime, with the sodium clay subsoil causes an improvement in soil texture.

Further laboratory and field work are required before the problem is elucidated. Field trials, varying the period of flooding in presence and absence of small dressings of ground limestone, have been laid down.

During the last eighteen months a detailed soil survey of the cane soils has been carried out. 5,786 soil samples from 2,893 sites, spaced out over 34,617 acres, have been collected and submitted to preliminary laboratory examination during this period. Frequency tables for these determinations are appended.

TABLE I

Distribution of Samples according to Normal Reaction (Quinhydrone Electrode)

Normal Reaction	Below pH 4·00	pH 4·00 to pH 4·99	pH 5·00 to pH 5·99	pH 6·00 to pH 6·99	Above pH 7·00
Topsoil 0–1 ft	10	1,487	1,260	124	12
Subsoil 1–2 ft	30	1,387	860	541	75

TABLE II

Distribution of Samples according to Exchange Reaction

Exchange Reaction	Below pH 3·00	pH 3·00 to pH 3·99	pH 4·00 to pH 4·99	pH 5·00 to pH 5·99	Above pH 6·00
Topsoil 0–1 ft	nil	1,768	1,032	80	13
Subsoil 1–2 ft	nil	1,504	689	560	140

TABLE III

Distribution of Samples according to Index of Texture [1]

Index of Texture	0–20	21–30	31–40	41–45	46–55	56–65	Above 65
Topsoil 0–1 ft	16	36	205	546	1,554	357	179
Subsoil 1–2 ft	12	29	122	303	1,964	434	29

[1] *F J Hardy*, Journ Agric Sci (1928, **18**, 252–256)

TABLE IV

Distribution of Samples according to Content of Soluble Salts

% Soluble Salts	0·000 to 0·050	0·050 to 0·100	0·100 to 0·200	0·200 to 0·300	0·300 to 0·500	Above 0·500
Topsoil 0–1 ft	2,449	365	59	15	2	3
Subsoil 1–2 ft	1,238	425	821	363	43	3

It will be seen that the majority of the soil samples are acid in reaction. This finding is of interest, as the late Sir John Harrison (*West India Bulletin*, 1909, pp. 27–28) described these soils as alkaline. Marked changes in reaction have taken place in the colony's cane soils during the last twenty-three years. The manurial practice of the colony consequently requires overhauling. Field experiments in progress indicate response to dressings of ground limestone and suggest that the varied soil types possess differing nitrogen requirements.

Most of the soils have indices of texture varying between 46 and 55 and are heavy clays.

The soluble salt content of the topsoils is, in general, low. The salinity of the subsoils is more marked, and in some areas the concentration of soluble salts (mainly chlorides, sulphates and bicarbonates of sodium and magnesium) is inimical to the growth of cane.

Two profile pits, the one in front land clay soil, and the other in the pegasse soil type, have recently been opened to a depth of 72 in. The soil was carefully sampled in 6-in. layers.

In *the front land clay* profile the alkalinity increased with increasing depth. The 0–6-in. layer had a normal pH of 5·09, while the 66–72-in. layer had a normal reaction of pH 8·22. The soil texture increased with increasing depth; the 60–66-in. layer consisted, however, of lighter soil (index of texture 30). The salinity increased with increasing depth; a sharp break in the curve was noted in the 60–66-in. layer.

In the *pegasse* profile, soil acidity increased with increasing depth. The 0–6-in. layer had a normal pH of 5·61, while the 66–72-in. layer had a normal pH of 4·21. The soil texture did not vary greatly throughout the profile. Soil salinity was low and showed little variation.

A number of well-designed manurial experiments have been placed on representative areas of each soil type.

Padi Soils.—Thirty-two composite samples of soil from the padi lands of the Essequibo coast and Wakenaam Island have been examined in detail and the yields of the particular areas are being recorded. Generally, the soils contain a sufficiency of available potash, but the supplies of available phosphate are low.

Two comprehensive manurial experiments with padi have been carried out at different centres. Artificial fertilisers had no effect at one centre, while at the other centre small responses of the order of 100 lb. per acre were obtained with dressings of superphosphate and with dressings of rice straw. Well-cultivated padi lands of the

colony yield, without fertiliser, about 3,000 lb. padi per acre. This general yield is much higher than that obtained in most of the other tropical colonies where large increases of padi are obtained on manuring. It seems probable that the plant nutrient status of most of the colony's padi soils is too high to expect large increments due to manuring.

Nigeria.—The following report has been furnished by Mr. H. C. Doyne, Senior Agricultural Chemist, regarding the work carried out by the Chemical Section, Southern Provinces, during the half-year ending December 31, 1932.

Up to the time of writing 1,678 soil samples have been received in connection with the Soil Survey of Nigeria since its inception. During the last half-year reports have been sent out on 348 soils. The routine analysis of soils consists of a mechanical analysis and pH, exchangeable base content, lime requirement and total carbon and nitrogen determinations. In some instances determinations have been made on the specific conductivity of the filtered extract of a soil-water suspension after standing overnight and after seven days. Fusion analyses of clay fractions have been undertaken on a few soils.

Determinations of pH, free calcium carbonate, exchangeable bases and lime requirement are being carried out on soil samples from plots which have been treated with varying amounts of quicklime and limestone, the soil samples being taken at intervals of four months.

Profile examination of soils on which cocoa flourishes and on which it has failed have been, and are being, undertaken.

An investigation into the soil problem incidental to a disease on yams is being carried out.

Examination of the horizons and their clay fractions of soil profiles derived from igneous and sedimentary rocks have been, and are being, undertaken. This work includes the determination of iron and aluminium soluble in a weak acid ammonium oxalate solution.

Insect Pests

Locusts

Gold Coast.—According to the report of the Director of Agriculture, for the period January–June 1932, locust invasion in the early months gave some cause for alarm. The swarms, however, were most common in the southern savannah areas along the littoral. On this occasion they extended from the eastern frontier to as far west as the

Ancobra River and beyond, i.e. longitude 2·30° W. Oviposition took place over the greater part of this area, and with the early rains hoppers became common and attacked the first sowings of cereal crops. Continued rains, however, disposed of the pests, and the second sowings of cereals were not harmed. Little trouble occurred in the Northern Territories and, except in a few remote places, crops were not interfered with.

BEVERAGES

Cocoa

Gold Coast.—The report of the Director of Agriculture, for the period January–June 1932, states that work on cocoa carried out by the Department includes port inspection of all shipments for export, general research on the various problems connected with the propagation, cultivation, harvesting and curing of the crop, together with storage of the product. Producers have been further assisted with marketing by the promotion and guidance of co-operative societies in all the more important production areas.

Cocoa Producers' Co-operative Societies.—The audit report for 1931/32 (*Department of Agriculture Bulletin No. 26 of 1932*) gives full details of this movement, which may now be regarded as definitely established. Progress during the past year has been the most marked since the inception of the movement, as is portrayed by the following brief summary:

Period.	No. of Societies.	Membership.	Subscribed Capital.	Cocoa Sold.
1929/30	31	946	£1,329	355 tons
1930/31	116	2,176	£1,708	619 ,,
1931/32	275	5,137	£3,732	2,248 ,,

Of these societies 206 marketed cocoa in the 1931/32 cocoa crop year. The total of 2,248 tons realised the sum of £40,296.

Inspection of Cocoa.—The work of inspection at the ports was continued as in past years, all lots of cocoa shipped were inspected and certified. The following table gives the defects and purities of the crop for the past five crop years.

	Percentage of Defects (Weighed Means).					
Year.	Mould.	Germinated.	Slatey.	Weevil.	Other.	Purity.
1927/28	3·4	3·3	4·8	0·6	0·6	88·5
1928/29	3·8	2·4	5·7	0·6	0·8	88·4
1929/30	3·3	1·2	6·4	1·7	1·2	87·7
1930/31	3·6	2·2	4·6	1·0	0·8	89·1
1931/32	4·1	2·6	5·2	0·6	1·7	89·3

It will be observed that there has been no significant increase or decrease in the purity coefficient since the inception of the work.

The work of inspection at up-country centres was confined to parcels prepared, for marketing, by cocoa producers' co-operative societies. The total amount inspected was 2,248 tons, and the purity of this quantity, as shown in the following table, is striking when compared with the purity of non-members' cocoa exported during the past season :

District.	Tons.	Mould.	Germinated.	Slatey	Weevil	Other.	Purity.
Krobo .	315·8	0·4	0·4	1·5	0·1	0·7	96·9
Nsawam .	189·4	0·4	0·9	1·6	0·0	0·7	96·4
Koforidua	93·6	0·4	0·6	2·3	0·0	0·6	96·4
Peki .	144·5	1·0	0·8	1·9	0·0	0·5	95·9
Oda .	152·6	1·1	0·8	1·3	0·0	1·0	96·1
Cape Coast	60·2	0·4	1·7	1·3	0·0	0·3	96·4
Saltpond .	23·9	0·3	0·9	2·1	0·0	0·5	96·6
Winneba .	76·8	0·3	1·2	1·1	0·0	0·9	97·3
Sefwi .	138·0	0·2	0·1	1·1	0·0	0·0	97·8
Bekwai .	181·3	0·3	0·3	1·8	0·0	0·3	97·0
Kumasi .	293·9	0·3	0·3	0·9	0·0	0·1	98·5
Offinso .	226·5	0·2	0·6	0·8	0·0	0·1	98·4
Efiduase .	219·7	0·1	0·3	0·9	0·0	0·1	98·5
Juaso .	80·1	0·3	0·5	1·1	0·1	0·3	97·8
	2,248·3	0·4	0·6	1·3	0·04	0·4	97·3

This serves to show that in every section of the country in which cocoa producers' societies were fostered, the purity of the societies' cocoa was excellent.

Insect Pests of Prepared Cocoa.—The weevil, *Aræcerus fasciculatus*, is known to attack wet cocoa immediately after fermentation. The extent to which infestation can take place in dry or partially dried cocoa is being investigated. A study of the life-history of the Phycitid moth, *Ephestia elutella*, is likewise in progress. A second moth, not yet identified, has been found in cocoa of very inferior quality. A fourth pest, a Nitidulid beetle, *Carpophilus* sp., has been found in wet cocoa, particularly that which is mouldy. Investigations are being made to ascertain if this beetle will attack cocoa as a primary pest.

Nigeria.—Reference to the cocoa selection work being conducted at the Moor Plantation, Ibadan, has already been made in this BULLETIN (1932, **30**, 205, 323). Mr. O. J. Voelcker, of the Botanical Section, Southern Provinces, in his report for the period July–December 1932, states that as a result of self-pollinating flowers from the ten selected trees, sufficient seedlings are now available to plant up 2 acres at Ibadan and 8 acres at Owena. Owena

is situated in a forest reserve in Ondo Province which is the centre of a rapidly expanding cocoa industry ; this new plantation is at a sufficient distance from any native cocoa farm to prevent out-pollination, and it is expected to form a nucleus for the distribution of superior seed. At both stations the selfed progeny of the ten trees will be planted in such a way that the yields of each selection may be compared one with another on a statistical basis.

An investigation on the controlled pollination of cocoa has now been carried out over twelve consecutive months, and the results are incorporated in a paper, " A Study of Controlled Pollination in Cocoa (*Theobroma cacao*)," which has been accepted for publication in the 1932 *Bulletin* of the Agricultural Department. This investigation was undertaken with the object of discovering a suitable technique and of ascertaining the optimum seasonal and climatic conditions, not only for successful fertilisation, but also for limiting the losses due to pod shedding after fertilisation. As a matter of routine, a number of flowers were pollinated each day on six Forastero trees, and a record was kept of every flower so pollinated. Those flowers which fell before the fourth day after pollination were considered not to have been fertilised. The general conclusions of this work may be briefly summarised as follows :

(i) A high percentage of flowers artificially pollinated at any season, and under a wide range of climatic conditions, are fertilised. The percentage over the whole twelve months was 86 per cent.

(ii) Flowers pollinated between the end of April and the middle of July gave the maximum production of mature pods.

(iii) No mature pods were obtained from flowers pollinated between the middle of August and the end of November, but it must be mentioned that there is a scarcity of flowers during this period.

(iv) At all seasons of the year pod shedding was heavy for about eight days after fertilisation.

(v) From the beginning of February to the middle of May shedding was continuous among pods of less age than fifty days after pollination ; fruits that reached that age eventually matured.

(vi) With flowers pollinated from the middle of May to the beginning of September, an interval of about three weeks was noted in which no shedding took place ; this was followed by losses up to the eightieth day.

Advantage was taken of these results when the programme of self-pollinating flowers from the selected trees

was laid down. No pollination was attempted before April 27, or after July 14, 1932. In all, 441 flowers from the selected trees were artificially pollinated of which 264 produced mature fruits.

Mr. J. West, of the Botanical Section, Southern Provinces, reports that experiments on the control of Black Pod (*Phytophthora Faberi* Maubl.) of cocoa were inaugurated early in 1931 by Mr. Laycock, the then Senior Mycologist. There are four plots, each consisting of a treated and an untreated section. Each treated section was originally given a heavy pruning and thinning. Three of these sections are given four applications each season of a Bordeaux Mixture spray, a Copper dust, and a Sulphur dust, respectively. In the fourth treated section sanitary measures only are practised. On both the treated and corresponding untreated sections, a count is made at each harvest of good and black pods, and the good and diseased beans are weighed.

The percentages of diseased beans for the full 1931–32 season were as follows:

Plot 1	Treated	2·6 per cent.	(Bordeaux Mixture Spray)
	Untreated	4·8 ,,	
Plot 2	Treated	7·1 ,,	(Copper Dust)
	Untreated	11·2 ,,	
Plot 3	Treated	4·5 ,,	(Sulphur Dust)
	Untreated	7·0 ,,	
Plot 4	Treated	4·0 ,,	(Clean Sanitation)
	Untreated	4·1 ,,	

It will be seen that the spray and the two dusts have reduced the loss due to disease. The results for the present season bear this out in a more marked degree. In Plot 4 the methods employed have so far proved ineffective.

From the cultural point of view, the plots show an interesting reaction in yield to the initial heavy pruning and thinning.

		Untreated. Yields in lb Dry Beans per Acre	Treated. Percentage Gain or Loss on Untreated Section.
Plot 1	1931–32	796	− 3
	1932–33	500	+ 69
Plot 2	1931–32	943	+ 16
	1932–33	910	− 28
Plot 3	1931–32	1,712	− 1
	1932–33	1,169	+ 5
Plot 4	1931–32	1,207	− 6
	1932–33	632	+ 19

The 1931–32 season includes both the main and Easter crops, while the 1932–33 season contains the main crop only. With the exception of Plot 2, the initial pruning

has resulted in a decrease in yield followed by an increase which has more than made up the balance. Plot 2 is situated on the poorest type of soil, and the trees have shown a rather excessive amount of die-back this season. In each plot the trees are at least ten, and in one instance twenty, years old and are planted at 500 to 750 stands to the acre. Next season should show whether, in spite of these factors, the present higher rate of yield can be maintained or whether there will be a falling away as in Plot 2. The figures have additional interest in that they bring out the comparatively high yields of cocoa which are obtained on native farms in Nigeria.

Cereals

Guinea Corn

Nigeria.—Mr. J. K. Mayo and Mr. C. B. Taylor, Agricultural Botanists, Northern Provinces, have furnished the following report on the work on guinea corn carried out during the period ending December 31, 1932 (see also this Bulletin, 1932, **30**, 207).

(*a*) *Yield Trials.*

Trial No 1 Samaru Plantation

Average yield per acre, 26 eighth-acre plots, control	817	lb. grain.
Average difference per acre, 8 eighth-acre plots, Strain FB	$+81 \pm 37$	,,
,, ,, ,, 8 ,, ,, ,, FA	$+54 \pm 37$	,,
,, ,, ,, 8 ,, ,, ,, FD	$+49 \pm 37$	,,

Trial No 2 Botanical Small-scale Yield Trial

Randomised blocks. Six repetitions. Size of single plot, $\frac{1}{40}$ acre

Average yield per acre, control	1,226	lb. grain.
Average difference per acre, Strain FA	$+ 76 \pm 97$	,,
,, ,, ,, ,, FB	$+ 57 \pm 97$	,,
,, ,, ,, ,, J	$- 6 \pm 97$	,,
,, ,, ,, ,, L (FB selection)	$+129 \pm 97$	,,
,, ,, ,, ,, FA selection	$+122 \pm 97$	,,
,, ,, ,, ,, FD	$+ 20 \pm 97$	,,

The results of these two yield trials were disappointing (strain FB had given increases of about 25 per cent. in the previous two seasons), but can possibly be explained by the fact that the control seed consisted largely of a variety called Mori, noted for its capacity to yield well on good land, whereas Farafara, the source of our selections, is merely a good all-round variety, but not grown on the richer soils. Both belong to *Sorghum guineense* var. *involutum*. The two yield trials were conducted on land in good heart, hence the results do not necessarily indicate that strain FB is losing its high-yielding capacity.

(*b*) *Multiplication of Strain FB.*

Shika Stock Farm, 45 acres.	Average yield of grain per acre .	600 lb.
Maigana Plantation, 10 acres.	Average yield of grain per acre .	640 ,,

(*c*) *Distribution of Strain FB to Native Farmers.*—In spite of having 7 tons of this strain available for distribution to the native farmers, it was decided not to hurry distribution by any organised method, and merely to offer to exchange FB seed for native seed, weight for weight with the addition of a small cash premium (actually a penny per 30 lb. seed), in order to see what response would be forthcoming. Fifty farmers took advantage of the scheme, and we estimate that they grew 100 acres with an average yield of 500 lb. grain. This next season it is probable that more farmers will participate, as the strain has acquired a local reputation due to the fact that it threshes out cleanly and easily, its yielding capacity not being so obvious.

(*d*) *Purity of Strain FB.*—In distributing this strain we have made no claims as to its purity, but merely as to its yield. After three years of selfing before multiplication it is still very impure in glume colour and head shape. Although the main glume type is a half-way stage between pure white and pure black, and although the main head shape is compact, we are still getting heads with white or jet-black glumes, and also long lax heads. Accordingly we are continuing selfing and reselecting each year in an endeavour to produce a pure strain combining the present good points.

(*e*) *Selection in "Kaura" Guinea Corn.*—In view of our apparent success in selecting within the Farafara variety, we have now started selection within Kaura, the second most popular Zaria variety (*Sorghum* near *S. caudatum*).

Rice

British Guiana.—The Director of Agriculture has furnished the following report on padi variety work conducted in the Colony, 1928–32.

Systematic improvement work with rice began in the autumn of 1927 with the reorganisation of the Department.

Pure Line Selection.—The commercial varieties then under cultivation were badly mixed with red-grained, awned and other types. The colony's yields were consequently falling while the quality, too, had deteriorated.

Large numbers of plants of each variety were selected and planted in progeny row plots. The purest of these were used for extension and single-plant selections were

repeatedly made. By 1930 it was possible to lay down variety trials which resulted in the elimination of all undesirable types and poor yielders. In addition, introductions of new varieties from other rice-producing countries have been gradually added to the Department's type collection, while in 1931 the appointment of a plant breeder for rice work was made possible through assistance from the Colonial Development Fund.

Hybridisation.—A number of crosses have been made primarily with the object of securing a heavy-yielding short-aged padi and the F_3 generation has already been planted out. In several crosses a complication has arisen due to incompatibility of varieties which results in some cases in a high degree of sterility of the hybrids, and in others in the production of chlorophyll-deficient seedlings. A close study is being made of the inheritance of these and other characters.

Variety Trials.—Variety trials have been conducted during the last two years with purified strains of Demerara Creole and Blue Stick, the commonly grown varieties, along with the more promising and newer types.

The variety No. 79, recently developed by the Department of Agriculture, heads the list. Two new varieties from India and Trinidad show great promise, and ultimate selection for distribution will depend largely on ancillary factors, such as milling quality, strength of straw, etc.

Spacing Experiments.—A preliminary spacing experiment was laid down, but wide enough extremes were not included to set definite limits as to spacing, though the results indicate that the optimum is reached at 8 × 8-in. spacing with four plants to each clump. The number of ripe panicles produced per clump increases with the spacing but is not affected by the number of plants per clump. If the spacing is increased beyond 10 × 10 in. the crop tends to ripen unevenly. Panicle length appears to be very susceptible to environmental conditions and is reduced both by close spacing and by increasing the number of plants per clump.

Seed-selection Experiments.—With the assistance of the Colonial Development Fund, mechanical threshing machines and winnowing machines have been acquired by the Department and demonstrated to rice farmers. A seed-selecting machine was also obtained which separates the seed padi into three grades according to size, the idea being that the larger grains will produce more vigorous plants and therefore a greater yield than the smaller grains. This theory is open to controversy, and the yield trial conducted with the four grades showed no significant

differences in yield from the small, medium, large and unseparated seed. The mean yields per acre are shown below :

Grade of Seed.	Yields in lb. per Acre.
Small	2,142
Unseparated	2,268
Large	2,282
Medium	2,310
Significant Difference . . .	287

Pure Line Seed Padi Distribution.—In order to extend the cultivation of pure seed the Department has evolved a scheme for the distribution of seed, and also for the maintenance of supply when the initial stages have been passed. Briefly, the system is this : The most promising varieties are kept under observation at the Central Experiment Station, Georgetown, and are sent out to the District Experiment Stations for variety trials. The varieties finally selected on the basis of yield and milling quality are distributed to selected rice-growers who cultivate the seed on private seed farms, as far as possible under the supervision of the agricultural officers of the district.

To encourage full co-operation of the farmers, padi competitions are run in the districts and valuable money prizes offered. Further, under this scheme the Department has the option of purchasing any padi, which may be of sufficiently high standard for its requirements, at a slightly higher figure than existing rates. The purchased padi is winnowed, dried and stored in seed barns, of which there are now seven erected through the assistance of the Colonial Development Fund. Certificates signed by the Director of Agriculture are given to those farmers who take part in the pure line padi scheme and whose padi is of sufficiently high standard of purity and uniformity.

The padi stored in these barns is distributed by the agricultural officers to farmers in the districts at a figure which is calculated will just cover actual expenses. In addition, certified farmers are also encouraged to sell their pure line padi to other growers who may want such padi for seed purposes.

The Supernumerary Entomologist, who has devoted much time to a study of the rice weevil (*Calandra oryzæ* L.) under local conditions in British Guiana, reports as follows :

(i) An attempt has been made to correlate the prevailing relative humidity of the wet and the dry seasons with the hardness of rice and with the prevalence of weevils. Six bags of rice containing weevils were sampled

at the end of September, at the end of October, and on November 5, 1932.

Number of Weevils

	Dead.	Live.	Total.
September	1,344	327	1,671
October	1,954	236	2,190
November	1,873	219	2,092

These figures show that the mortality of the rice weevil during the dry months of September and October is greater than the rate of increase. Figures for the wet season are not yet available.

Experiments to determine the effect of relative humidity on hardness showed that rice kept in an atmosphere of 90 per cent. relative humidity became markedly softer than that kept in an atmosphere of relative humidity 50 per cent., but it is not yet possible to say whether the mean relative humidity of the wet season is sufficiently higher than that of the dry season to affect the hardness of rice stored in bags.

Experiments indicate that the larval period of the weevil is elastic and that it lengthens with the hardness of the rice and that some rice grains are so hard that the larvæ perish soon after burrowing has commenced. These experiments are being repeated.

(ii) A machine has been constructed to measure the hardness of rice in terms of pounds pressure required to crack the grain.

(*a*) All of the commoner local varieties were examined, and the fact emerged that there is no varietal difference in hardness.

(*b*) Rice varies in hardness according to the method of preparation. Thus white rice is softer than parboiled rice.

Variety 79

	Parboiled Rice (41 Days after Parboiling and Milling).	White Rice (41 Days after Milling).
Hardness	11·14 lb.	4·28 lb.

(*c*) Parboiled rice increases in hardness with the lapse of time after parboiling.

Variety Demerara Creole

	Approximately 6 Months after Parboiling.	Approximately 1 Month after Parboiling.
Hardness	19·14 lb.	15·14 lb.

(iii) Experiments were conducted to determine the effect of relative humidity on the life of the adult weevil.

The figures obtained show that the weevils thrive best in atmospheres of relative humidity 90–100 per cent., and that the prevalent relative humidity during the dry season is low enough to have a detrimental effect on the adult weevil.

The following figures represent the percentage mortality of weevils on exposure to atmospheres of different relative humidity for 90 hours :

Relative Humidity.	Percentage Mortality.
90	0
80	5·5
70	10
60	16
50	25
40	42
30	89
20	100
10	100
0	100

(iv) As was shown in (ii), rice hardens with the lapse of time after parboiling. This process, however, is a slow one. Methods of hastening the hardening have been investigated.

(*a*) *Desiccation.*—When rice is placed in a desiccator (calcium chloride) the hardening is proportional to the loss of moisture up to a point where the rice has lost 50 per cent. of its water content and has reached a hardness of 35 lb. This point is reached after 70 hours in the desiccator. Beyond this point there is no further hardening, though there is further loss of water. It is not possible to harden rice by this method beyond 35 lb. If desiccation be continued, the grains disintegrate.

(*b*) *Heating.*—Heating drives off the moisture and hardens rice.

Variety A 16–34 heated for 45 minutes at 36–39° C.

Hardness before heating	10·7 lb.
,, after heating	19·7 ,,
,, 20 hours after heating	14·0 ,,

After 4 days the rice returns to its normal hardness, i.e. 10·7 lb.

(v) *The Practice of Rehulling.*—" Rehulling " (i.e. passing rice through the hulling machinery with the object of pulverising and so eliminating the weevil-infested grains) weevil-infested rice, with the object of rendering it fit for exportation, is a common practice. Experiments were conducted to determine the precise effect of rehulling on the weevil. Figures obtained show that of the survivors :

73·5 per cent. were in the egg stage at the time of rehulling.

21·3 per cent. were in the first half of larval stage at the time of rehulling.

4·5 per cent. were in the second half of larval stage at the time of rehulling.

None survived in the pupal stage. Emergence commenced on the fifth day after rehulling, showing that larvæ survived even in the prepupal stage.

Gold Coast.—According to the Report of the Director of Agriculture for the period January–June 1932, plots under the various types of rice introduced during the previous year, were established at Kpeve Investigational Station for the purpose of ascertaining and recording behaviour and yields under dry conditions. Full details are given in *Year Book* 1930, Paper No. XXXIII, pp. 318 and 319. Types of particular merit have been selected for further trial. During the period under review there were no marked changes in atmospherics, rainfall and other factors which might have influenced changes in yields, but in general the strains of rice giving comparative low yields in 1931 have shown distinct improvement in 1932, while the higher-yielding strains have shown a diminution during the same period. All the seed used this season was raised locally and it is assumed that the effect of environment is the influencing factor. At Esiama, in the Western Province, where swamp rice is the staple industry of the district, a small paddy investigation station is in being. The aim of this station is to obtain high-yielding strains of locally established rice which will mill easily and sell readily in the Colony. These trials have been in hand since 1929, and good progress is being made in working up a stock of seed paddy for final test preparatory to issuing small supplies to growers.

The Esiama rice factory was put down in 1926 with the object of encouraging the extension of the existing local industry to supply the general demand for rice outside the Axim District. Progress has not been so rapid as anticipated, but, nevertheless, it shows genuine improvement, and is likely to be permanent. The following figures for past and present periods show progress in extension and production :

Year.	Number of Producing Villages.	Production of Paddy. tons.
1926–27	13	35·28
1928–29	16	191·24
1930–31	28	289·25
1931–32	47	413·57

The increase during the current year may be regarded as a sign of the hard times through which this country, in common with most others, has been passing. Up to mid-November 1930 the value of rice per 100 lb. at the factory was 14*s*. It then dropped to 12*s*., and declined steadily until it reached 9*s*. in November 1931.

Legumes

Nigeria.—Mr. J. West, of the Botanical Section, Southern Provinces, in a report for the half-year ending December 31, 1932, states that the introduction of prominent edible bean types from abroad, although hitherto unsuccessful, is continued whenever possible. This year samples of the more important Lima beans of the United States were obtained via Kew and through the courtesy of the Bureau of Plant Industry, Washington. These have been multiplied in observation plots and will be tried out next season against the local Popondo selection (? *Phaseolus lunatus* forma *macrocarpus* Van Es.).

Of the hybrids recently raised, only one shows marked promise. A pure line supply of seed will be raised to give adequate small-plot trials against Popondo.

Owing to the great difficulty of procuring artificial crosses which has been experienced so far, attention has been given during the past season to the production of natural crosses. Out-pollination occurs to a slight extent in the selection plot each year. By growing the proposed parents in the same stands so that flowering is simultaneous, it is expected that the percentage of out-pollination will be increased. Seed from such plantings is sown in plots and any off-type plants which appear probably represent the desired hybrids.

Sugar

Cane

British Guiana.—The Director of Agriculture has furnished the following summary of sugar-cane variety work (1929–32) conducted by the Department.

There was some reason for believing that between 1893 and 1919 Sir John Harrison, in the Botanic Gardens, and later (1920–27) the Sugar Experiment Station, had exploited, with little success, most of the possible combinations between the canes long existent in the Colony and their descendants. It was therefore decided to stress, in the breeding work, crosses between local and introduced canes.

A considerable number of crosses have now been obtained, and they are in process of multiplication and selection. It has been found that the cross D.625 × S.C.12 (4) gives a large number of vigorous " selectable " seedlings under local conditions. Several Javan and Indian canes have been introduced, and are being used in the breeding work as well as tested for their own value as sugar producers, and there is soon to be removed from quarantine an interesting collection of Java-West Indian hybrids produced and selected at the Insular, Federal and Fajardo Experiment Stations in Puerto Rico.

A large number of experiments have been started on the Sugar Experiment Station and on co-operating sugar estates to compare the introduced canes and numerous semi-tested varieties, which had been selected at the station in later years, with D.625, the Colony's standard cane. There are now well over 100 varieties in these trials, which are all laid out to enable Fisher's analysis of variance to be applied to the data they yield.

Twenty-nine experiments have been reaped so far. In view of the fact that the work has only been spread over two seasons, and also as only comparatively few of the canes have been reaped as ratoons (and ratooning, moreover, is of major importance in this Colony) no definite conclusions have been drawn. The trials have, however, already permitted the definite elimination of many varieties, and they point to several others (e.g. 204/20, 207/20, 52/20 and S.W.3) as being equal to or better than D.625, although this cane still gives satisfactory returns, which are on the upward rather than the downward trend. As a result of the tests reaped so far, planters are being advised to make moderate and cautious extensions of Diamond 10 and P.O.J.2878.

The Entomologist in charge of sugar-cane moth-borer investigations in British Guiana has recently published an article in *Tropical Agriculture* (1932, **9**, 264–271) giving the results of an investigation into the resistance offered by different cane varieties to moth-borer (*Diatræa* spp.) attack. The results indicate that certain Barbados seedlings and Java seedlings are markedly less attacked than are the standard cane of the Colony, D.625, and other British Guiana seedlings. It seems probable that resistance to moth-borer damage is a strong character in certain seedlings and that this character is capable of transmission to the progeny.

The results also indicate that there is a close relationship between the extent of moth-borer damage and the

sucrose content of the cane. They suggest, also, that the same amount of borer damage may affect, in varying degree, the sucrose content of different varieties. It was not possible, owing to restrictions of sampling, to prove definitely the two latter points.

Root Crops

Cassava

Sierra Leone.—The following reports on work on mosaic disease of cassava carried out during the year 1932 have been furnished to the Imperial Institute.

Mr. C. Hargreaves, Entomologist, states that mosaic disease has apparently extended rapidly during recent years, the suspected carrier being an Aleurodid, but this is not yet confirmed. The non-development of the usual symptoms in plants growing in the insectary may be due to conditions of light, as was previously found to be the case during study of ground-nut mosaic ; and work is proceeding accordingly.

Mr. F. C. Deighton, Mycologist, reports that in a preliminary experiment, mosaic disease was successfully transmitted by strip-grafting to a few healthy plants. Field observations indicate that there are two short-season sweet varieties in Sierra Leone which are very resistant to mosaic disease.

Yams

Gold Coast.—According to the report of the Director of Agriculture for the period January–June 1932, trials with various local and introduced food crops are being carried on at Tamale in the Northern Territories, and in these trials a good deal of attention has been given to yams (*Dioscorea*). In this connection interesting data were obtained concerning the influence on yields of the height of supports used for the vines. The effect of varying heights of supports for the foliage showed that significant increases in yield could be obtained from 2 to 6 ft., the varieties Labaco and Dakpam showing increases of 2,500 lb. per acre. The latter, with supports 6 ft. in height, gave a mean yield of 11,278 lb. per acre. There is considerable difficulty in obtaining long sticks for supports at Tamale, but it is found that teak grows well, and when coppiced will supply an abundance of suitable sticks for supports.

Yam tuber rot was further investigated by the Mycologist. The trouble occurs mainly in storage, and it has been found (*a*) that infection probably takes place in the soil before harvesting as indicated by abnormal vegetative symptoms ; (*b*) that three species of bacteria found in the

tubers are not the cause ; (*c*) that *Botryodiplodia theobromæ* is confirmed as the causative fungus. Investigations are now in hand to determine by what means infection occurs.

Fruits

Citrus

Sierra Leone.—The following statements relating to the work carried out during the year 1932 have been communicated.

Mr. C. Hargreaves, Entomologist, reports that the problem of fruit-piercing Lepidoptera is very serious as the puncture almost invariably results in development of rot inside the fruit, and fruit-fall ; and grapefruit, mandarine, tangerine, sweet lime and sweet orange are attacked. Little is known of the bionomics of these insects ; over forty species are involved, most being Noctuids, which pierce fruit at night, the others Nymphalids, whose damage is diurnal. The main species are *Achæa catocaloides* Guen. and *Othreis fullonica* L., and the chief damage is done during the months of April, May and June, when the main crop is approaching maturity. Most of the punctured fruit falls, sometimes one or two days after damage, but this period appears to be dependent upon the kind of citrus involved, the degree of maturity of the fruit, and weather conditions.

Artificial piercing was resorted to in order to elucidate this, fruits of various ages being used (this was not during the fruit-moth season), and the period varied from eight days to over five months ; in a few cases the wound had healed. The cause of the fall appears to be due to fungi and other organisms which enter at the point of damage, and even when a sterilised needle was used for the purpose they still occurred, so that it is not necessary for them to be introduced mechanically by the proboscis of the insect. The organisms develop very rapidly in ripe fruit.

For control, poisoned baits have been used, and out of those containing respectively sodium arsenate, sodium arsenite, lead arsenate, sodium fluoride and sodium fluosilicate, the sodium arsenite has been found to be the most satisfactory ; but as in some cases the moths may feed and fly off to die elsewhere, an endeavour is being made to prevent this, so that a real comparison of the different agents may be made, and possibly a suitable substitute for arsenical compounds found.

Continual collection and breeding work is carried on with a view to the finding of larvæ and larval food plants

of the insects, since this may place us in a better position regarding control.

Mr. F. C. Deighton, Mycologist, reports that observations on the incidence of scab (*Sporotrichum citri*) on leaves and fruit have been continued on the young grapefruit plot (planted 1927) at Njala. While a few leaves and flowers are produced by one tree or another throughout the year, including the dry season, the main flush seems to occur about the beginning of March, with minor flushes in May, July and September. Leaves of the main early March flush remain practically free from scab, and infection becomes increasingly severe on young leaves produced after this up to September–October, after which it decreases again with the advent of the dry season. A few scab lesions can be found on some of the occasional leaves produced in the height of the dry season. An attempt is being made to correlate weather conditions with scab infection, but results are inconclusive to date.

In the field, punctures made by fruit-piercing moths or by artificial means are almost invariably followed by rotting. The several different fungi concerned are being studied.

Spices

Chillies

Nigeria.—Mr. O. J. Voelcker, of the Botanical Section, Southern Provinces, in his report for the half-year July–December 1932, states that a collection of chillies (*Capsicum* spp.) planted at Moor Plantation, Ibadan, in June 1932, is now fruiting. It appears that the collection contains about equal proportions of *Capsicum annuum* L. and *C. frutescens* L. A very great diversity of fruit form has been noticed, even among those planted as one type. It is probable that this variation is due to two causes: firstly, the almost certain mixture of types in the original samples which were bought in local markets; and secondly, the heterozygous nature of the varieties themselves. Further work to obtain pure strains by self-fertilisation will await information on the European market possibilities of this crop.

Fodders

Nigeria.—Mr. K. T. Hartley, Agricultural Chemist, Northern Provinces, in a report for the period July–December 1932, states that the work on the composition of grasses is being continued. The twice-monthly analysis of a single species has now been carried almost through a

complete year. This particular grass, known locally as gamba (Rhodesian blue grass, *Andropogon Gayanus*), commences to grow as soon as it is burned or cut down in the dry season—about January—and continues to develop until it comes into flower in October. The first small leaves in January contained up to 1·7 per cent. nitrogen and about 25 per cent. crude fibre. The latter remains fairly constant until the rains commence in April, while the nitrogen content drops to something below 1 per cent. Immediately after the first rain there is rapid growth, the nitrogen rises at once to about 1·5 per cent., remains there for about a month, and then drops steadily to about 0·4 per cent. in September, when the flower stalks are forming. Simultaneously the fibre content gradually rises to over 40 per cent.

A large number of other single species have also been analysed at a standard time—just as they were coming into flower. Considerable differences in quality have been shown in this way, and these results are being applied in the making up of experimental seed mixtures for pasture and hay.

Oil Seeds

Coconuts

Gold Coast.—The Director of Agriculture, in his report for the period January–June 1932, states that, owing to decreased staff and the falling off in revenue, savings had to be effected and the Department was obliged in March to cease operations at the Atwabo Plantation. The Plantation is in the custody of the District Commissioner pending its restoration to the Stool authorities—the owners of the land. While its retention would have been valuable as a means of obtaining exact and reliable information regarding yields, effects of manuring, and methods of preparing copra, the main purposes of the plantation, as a demonstration of the importance that Government attributed to this crop, and as a source of seed-nuts, have been fulfilled. There are now 847 acres of coconut palms along the foreshore between the Ancobra River and the French frontier.

The industry in the Eastern Province is in the hands of the people and confined more or less to the Keta District which adjoins the eastern frontier. While there is a small export industry in copra there is little prospect of any material increases in areas, or yields, for neither soil nor rainfall approaches the optimum required. The domestic value of the palm is so great, however, that efforts will be continued to encourage its cultivation around the villages.

Ground-nuts

Nigeria.—In their report for the period ending December 1932, Mr. J. K. Mayo and Mr. C. B. Taylor, Agricultural Botanists, Northern Provinces, furnish the following particulars of ground-nut experiments, in continuation of results previously recorded (this BULLETIN, 1932, **30**, 212).

(*a*) *Zaria Spreading Ground-nuts.*—Strains KO and EB were given a further trial on Samaru plantation.

		Yield as Percentage of Control.		
		1932	1931.	1930.
Average yield in kernels p a , 15 eighth-acre plots, local ground-nuts . . .	760 lb	100	100	100
Average difference of 7 eighth-acre plots of KO	+30 ±3·8	104	113·3	116·7
,, ,, 7 ,, ,, ,, EB	+54 ±3·8	107·1	106·5	122·4

It is difficult to see any reason for this falling off, and in spite of our optimism last year, we shall have to discard these strains.

(*b*) *Zaria Upright Ground-nuts.*—

No 1. 1932 Yield Trial on Samaru Plantation

		Yield as Percentage of Control.		
		1932	1931	1930.
Average yield in kernels p a , 35 eighth-acre plots, local ground-nuts. . .	281 lb	100	100	100
Average difference in kernels p a , 6 eighth-acre plots, Bu	+80 ±19	128·5	117·1	118·8
Average difference in kernels p a , 6 eighth-acre plots, B1	+81 ±19	128·9	127·8	111·5
Average difference in kernels p a , 6 eighth-acre plots, Cc	+89 ±19	131·[illegible]	126·8	115·0
Average difference in kernels p a , 6 eighth-acre plots, C. com	+60 ±19	121·[illegible]	—	—
Average difference in kernels p a , 6 eighth-acre plots, C st.	+47 ±19	116·9	—	—

No. 2. Botanical Small-scale Yield Trial

Randomised blocks Six repetitions Size of single plot, $\frac{1}{88}$ acre.

		Yield as percentage of Control
Average yield in kernels p a , local ground-nuts .	589 lb	100
Average difference in kernels p a , Strain K (Bu selection)	+ 91 ±23	115·2
Average difference in kernels p a , Strain M (C com selection)	+ 99 ±23	116·8
Average difference in kernels p a , Strain N (C st. selection)	+ 4 ±23	100·5
Average difference in kernels p a , Strain R . .	+ 25 ±23	104·0
,, ,, ,, ,, ,, S . .	+ 7 ±23	101·0
,, ,, ,, ,, ,, T . .	+101 ±23	117·0

(*c*) *Upright* v. *Spreading Ground-nuts.*—A test was made between our best spreading and upright strains, the spreading being spaced at 1 ft. 6 in. and the upright at 9 in., on 2 ft. 6 in. ridges. These spacings were considered as optimum for the respective types.

	Yield as Percentage of Control.
Average yield in kernels p a , 10 quarter-acre plots, Strain Cc (upright)	728 lb.
Average difference in kernels p.a., 10 quarter-acre plots, Strain KO (spreading)	-135 ± 32 lb.

The native farmer uses spreading or upright groundnuts according to the custom of his district. But the upright type is more suitable for growing under cattle cultivation, and we wanted to find out if, in distributing our improved upright type to the native farmer we should be giving him a higher yielder, whichever type he grew previously.

(*d*) *Multiplication and Distribution of Upright Types.*—A small amount of multiplication was undertaken this year with the following results.

At Zaria, Strain Bi, 3½ acres, with average yield of 819 lb. kernels p.a.

At Zaria, Strain Cc, 4¾ acres, with average yield of 1,030 lb. kernels p.a.

In addition, Strain Bi was grown in various districts in order to discover whether it was suitable for long range distribution or only of use locally. At Kafin Soli farm, in Katsina, 130 miles from Zaria, it was a success. At Gusau farm, Sokoto Province, 120 miles from Zaria, there was no improvement. At Yandev farm, Benue Province, 300 miles from Zaria, it was successful.

(*e*) *Future of Strain Bi.*—It may now be assumed that Strain Bi is worthy of distribution and the ton of seed available will be multiplied as far as possible.

(*f*) *Kano Spreading Ground-nuts.*

No. 1. 1932 *Large-scale Yield Trial*

		Yield as Percentage of Control.		
		1932.	1931.	1930.
Average yield in kernels p.a., 45 eighth-acre plots, local ground-nuts	1,147 lb.	100	100	100
Average difference in kernels p.a., 9 eighth-acre plots, Strain Sc	$+220 \cdot 4 \pm 64$	119·0	106·9	124·2
Average difference in kernels p.a., 9 eighth-acre plots, Strain Pr	$+192 \pm 64$	116·9	104·4	121·0
Average difference in kernels p.a , 9 eighth-acre plots, Strain Lr	$+74 \cdot 6 \pm 64$	106·4	101·4	119·8
Average difference in kernels p.a., 9 eighth-acre plots, Strain Eb	$+101 \cdot 3 \pm 64$	108·9	93·1	119·2
Average difference in kernels p.a., 8 eighth-acre plots, Strain Philippine White .	$-213 \cdot 0 \pm 69$	80·8	90·6	119·0

No. 2. Small-scale Yield Trial

Randomised blocks. Six repetitions. Size of plot, $\frac{1}{88}$ acre.

		Yield as Percentage of Control.
Average yield in kernels p a., local ground-nuts	1,044 lb.	100
Average difference in kernels p.a., Strain 10 (Sc selection)	$+139 \pm 348$	111·0
Average difference in kernels p.a., Strain 9 (Pr selection)	$+182 \pm 48$	115·0
Average difference in kernels p.a., Strain 1 (Lr selection)	-107 ± 48	88·0
Average difference in kernels p.a., Strain 2 (Eb selection)	$+212 \pm 48$	118·2
Average difference in kernels p.a., Strain 32	$+195 \pm 48$	116·2

Strains Sc and Pr have shown that their failure in 1931 was, as was thought, due to the bad season. Strain Sc will now be multiplied, although one more year of trial is desirable, and a yield trial will also be conducted.

Sierra Leone.—Mr. C. Hargreaves, Entomologist, in a report on work carried out during the year 1932, states that observations regarding mosaic disease of ground-nuts indicate that two, probably three, viruses are involved, and in most cases infections are compound.

The disease can be transmitted by *Aphis laburni*, Kalt., during any part of the year, and the aphis and disease are definitely carried over the winter by volunteer ground-nut plants ; whether or not other plants are also concerned is not known, as no alternative food plants have been found. No other insect has been proved capable of carrying the disease.

Study is being made of the conditions governing the appearance, development, and spread of the disease.

Oil Palm

Gold Coast.—According to the report of the Director of Agriculture for the period January–June 1932, operations continued at the Butre Palm Oil Factory. This is a business proposition without any direct connection with the Department of Agriculture. Low prices for oil and kernels rendered profit-earning impossible, but the mill was able to pay its way, and this was made possible by selling oil locally for culinary purposes. More attention is being given to the extension of local marketing by packing high-grade oil in containers holding 4 gallons each and distributing them to the larger towns for sale.

The Bukonor Mill, previously referred to in this Bulletin (1932, **30**, 214) as being operated under the Government subsidy scheme, and obliged to close temporarily owing to low value of produce, has not been working during the period.

Nigeria.—Mr. E. H. G. Smith, of the Botanical Section, Southern Provinces, in his report for the period July–December 1932, gives the following yields of the larger groups of the Calabar plantation palms for 1931. The yields are expressed nominally as lb. of fruit per acre, and the averages over a period of years (1924–31) are included for comparison :

Type (or variety) of Palms.	Plot Number	No of years since plot planted out	Spacing.	Yield 1931.	Previous Average
Ordinary thick-shell palms . .	4	19	Modified square, approx 20 ft	3,455	3,210
Ordinary thick-shell palms . .	6	19	30 ft square	4,850	3,910
Ordinary thick-shell palms . .	10	18	25 ,,	4,650	4,380
Ordinary thin-shell palms . .	4	19	Modified square, approx 20 ft	2,110	2,420

The 1931 figures for the smaller groups of palms in plots 11 and 12, which include all the six recognised oil palm fruit types (or varieties) growing at Calabar, are well below those recorded for 1929 and 1930. The detailed yield data of the Calabar plantation palms appear in the departmental *Annual Bulletin*.

Shea

Gold Coast.—The report of the Director of Agriculture for the period January–June 1932, records that trials in the making of shea fat were continued at the small mill erected by the Department at Tamale. The working cost of extracted fat was found to be from £20 10*s*. to £23 10*s*. per ton, figures which do not include the cost of European supervision or depreciation on plant. The normal price of shea fat in London is £30 per ton, and transport charges for the 237 miles from Tamale to railhead, railing costs from Kumasi to Takoradi, ocean freight, and other charges to London, are in excess of the margin of £6 10*s*. to £9 10*s*. left after extraction. Even at 6*d*. per ton mile, the haul from Tamale to Kumasi costs approximately £6 per ton. The fat prepared at the mill was not exported, since that would quite obviously have been unprofitable, but is being sold locally in Kumasi and other markets. The retail price for small lots of fat is 3*d*. per pound, or £28 per ton, but the extent of the local market demand is not yet known. Tests have served to show that by effecting certain alterations and additions to the mill, the maximum

output would be 120 tons of fat per year, of 300 working days. While it is unlikely that shea-fat extraction will be found profitable, except perhaps for the limited local demand, the experimental mill will be maintained and further tests carried out.

FIBRES

Cotton

Gold Coast.—The Director of Agriculture, in his report for the period January–June 1932, points out that cotton development work in the Colony was summarised in *Year Book*, 1930, Paper No. XX, pp. 166–174, so far as trials in the Northern Territories were concerned. This paper served to show that the locally bred strain D.28 was likely to prove the most useful type for distribution, and work has therefore been concentrated on this—a type of American Upland origin. One of the secrets of the success of this type is that it flowers in the dry season, rather than during the rains, and thereby the loss due to flower and boll shedding is minimised. The following data relating to the best of the various strains under trial serve to show the outstanding merit of D.28.

Strain.	Seed-Cotton Yields per Acre.
D.28 (in rotation)	280 lb.
D.28 (no rotation)	204 ,,
Coconadas	189 ,,
Karangain	83 ,,

The yield of 200–300 lb. per acre now attained is the level at which cotton-growing in the Northern Territories would pay under ordinary normal conditions, but at present slump prices no cotton would yield sufficient to cover transport and other expenses from Tamale. The possibility of a revival in values, and the local demand for domestic purposes, warrant a continuance of work on this strain with the object of further improvement and distribution to local farmers.

Nigeria.—According to a report by Mr. E. H. G. Smith, of the Botanical Section, Southern Provinces, for the period July–December 1932, cotton harvesting was still in progress at the time of writing and thus little definite data could be furnished. He states, however, that the present season promises to be a very satisfactory one, and, compared with that of 1931–32, the incidence of the common Nigerian cotton pests and diseases has been markedly less on the resistant strains. The five New Guinea Kidney by Sea Island (cross) strains, the introduction of which from

Fiji for trial was mentioned in the July report, have not proved suitable to Ibadan conditions. The leaves of all plants of these strains were found to be almost completely glabrous, and from about one month before the beginning of flowering until the cessation of the rains all plants were severely affected by Jassid (*Empoasca facialis*). This pest is only of importance at Ibadan when attempts are made to grow susceptible cotton strains. Flowering on the Fiji plants was poor and boll shedding was severe, with the result that very few bolls will mature.

MINERAL RESOURCES

CYPRUS

The Imperial Institute has received from the Acting Colonial Secretary the following report on mining in Cyprus during the six months ended December 31, 1932:

Although mining activities in the Colony continue to be affected by the world depression in trade, there were indications, towards the end of the year, of a better demand for minerals, shipping orders being encouraging. The Cyprus Mines Corporation, having completed their development programme, decided to close down the Mavrovouni mine at the end of the year pending the results of metallurgical tests of ore from this mine.

The following statistics refer to the work done at the Skouriotissa pyrites mine of the Cyprus Mines Corporation:

	Second 6 Months. 1932	Second 6 Months. 1931.
Tonnage mined	20,256	86,088
Tonnage exported	48,592	94,724
Underground labour (average per day)	178	412
Total surface and underground labour (average per day)	640	996

The following statistics refer to the development at the Mavrovouni pyrites mine of the Cyprus Mines Corporation:

	Second 6 Months. 1932.	Second 6 Months. 1931.
Boreholes, footage sunk	nil	nil
Prospect drilling (underground), ft.	1,586	6,826
Development, total footage	13,693	5,691
Tonnage mined	59,072	20,935
Tonnage exported	56,125	21,211
Labour, underground only (average per day)	324	254
Total underground and surface labour (average per day)	559	579

The following table refers to the work done at the Lymni mine of the Cyprus Sulphur & Copper Co., Ltd. :

	July only. 1932.	Second 6 Months. 1931.
Underground development footage . .	nil	533
Opencast, overburden removed, cubic yd..	1,966	28,148
Tonnage mined	239	967
Copper precipitate produced, tons . .	1	8
Average daily labour	61	74

The following statistics refer to the work done at the Troodos mines of the Cyprus Chrome Company, Ltd. (Mining Lease and Prospecting Permit areas) :

	Second 6 Months.[1] 1932	Second 6 Months. 1931.
Development, total footage . . .	752	327
Tonnage mined	287	nil
Tonnage exported	nil	nil
Average daily labour	51	25

[1] *Four months only.*

The following statistics refer to the output of the Cyprus & General Asbestos Co., Ltd., Amiandos :

	Second 6 Months. 1932.	Second 6 Months. 1931.
Rock mined, tons	100,920	97,620
Rock treated, tons.	24,763	23,307
Finished asbestos produced, tons . .	1,161	1,123
Finished asbestos exported, tons . .	833	1,521
Average daily labour (quarries only) .	145	124
Average daily labour	341	287

Minerals exported, other than those dealt with above, were as follows :

	Second 6 Months. 1932.	Second 6 Months. 1931.
Terra umbra, tons	1,469	1,405
Terra verte, tons	3	1
Gypsum, tons	5,529	5,749
Building stone, cubic yd.	667	428

The figures previously given for the second six months of 1931 (see this BULLETIN, 1932, **30**, 60) should be amended in respect of the following :

Cyprus Mines Corporation, Mavrovouni mine—Tonnage mined should read 20,935.

Cyprus Sulphur & Copper Co., Ltd., Lymni mine—Tonnage mined should read 967.

FEDERATED MALAY STATES

The Imperial Institute has received the following statement from the Acting Director regarding the work of the Geological Survey Department during the half-year ended June 30, 1932.

The Director, Mr. E. S. Willbourn, went on leave on June 16, 1932.

The Mining Geologist, Dr. F. T. Ingham, spent a large proportion of this period in completing a detailed plan of the scheelite deposit at Kramat Pulai, near Ipoh, Perak. This occurrence is probably one of the largest and richest deposits of scheelite ore in the world. A joint paper by the Director and Dr. Ingham has been prepared and will be presented before the Geological Society at an early date.

A general slowing up of tin-mining operations is much in evidence due to restriction. A much greater activity with regard to the prospecting for gold in Pahang and Kelantan is taking place and, in June, Dr. Ingham visited a promising area in the former State.

The Assistant Geologist, Mr. H. E. F. Savage, made satisfactory progress with the detailed geological map of the country round about Sungei Siput North and hopes to have this map completed by the end of the year.

The Chemist, Mr. J. C. Shenton, spent most of the period carrying out general analysis. The work in the laboratory increased by 60 per cent., mainly due to the Tin Enactment, and a large number of tin assays had to be done on " amang " and tin ores for the Mines Department.

During the absence of the Director on leave, Mr. J. C. Shenton, the Chemist, was appointed Acting Director in charge of the administrative side of the Department and Dr. F. T. Ingham in charge of the geological side.

GOLD COAST

The Imperial Institute has received the following report from the Director regarding the work carried out by the Gold Coast Geological Survey Department during the second half of 1932.

During the major part of the period under review only one Geologist, Dr. W. G. G. Cooper, was in the field. He was engaged in mapping the geology of the Prestea gold belt. The underground workings of the Ariston gold mine were also carefully studied. The field-work has now been completed and the maps and plans to accompany a report on the goldfield have been prepared. It is hoped that the report will be published during 1933.

Plans of the chief bauxite deposits of the Gold Coast were prepared for a report which will probably be published as a *Bulletin*.

The Director and the other two geologists returned to the field during November and early December, and have since been engaged in investigating the auriferous possibilities of portions of the Sekondi, Axim and Tarkwa districts.

Some of the numerous gold prospects in the area between Axim, Banso, Bensu and Dixcove appear to be worthy of further investigation. Most of the prospects occur in Birrimian lavas in the contact aureoles of masses of sodic granite and diorite of the Dixcove type.

Traverses were made across the very thinly inhabited country south-west of the Fura river, in an attempt to pick up the extension of the Prestea gold belt. This work has shown that granitic rocks are much more abundant in this district than was formerly supposed, and that the potentially auriferous area is therefore considerably reduced. One bathylith of granite is at least 60 square miles in area.

In the vicinity of the lower Ankobra river near Banso, Akusuno and Esamang a number of small occurrences of iron ore, gondite and low-grade manganese ore were noted. The deposits are too small and of too low a grade to be of any commercial importance at the present time.

The manganese deposits extending for several miles in an E.N.E. direction from Dixcove were briefly studied. The amount of commercial ore does not appear to be large.

As the specific gravity and optical properties of an encrustation on a diamond from Akwatia, examined by the Director, indicated quartz and not wollastonite (see report for the half-year ended June 30, 1931, this BULLETIN, 1931, **29**, 345), the encrustation on this and four other diamonds from Akwatia were submitted to the Imperial Institute for analysis. They were found to be composed essentially of quartz with a small amount of a calcium compound soluble in dilute hydrochloric acid. The encrustation previously identified as probably wollastonite may have been a freak, but it seems more likely that it was also mainly quartz.

Analyses made by the Imperial Institute of a mineral tentatively determined by the Director of the Geological Survey as chrysoberyl confirm this determination.

Additional support for the theory that the diamonds at Akwatia are derived from ultrabasic igneous rocks is afforded by the discovery by the Imperial Institute of appreciable amounts of chromium sesquioxide—in one sample 1·19 per cent.—in the pisolitic limonite recovered from the diamondiferous gravels. Diamonds are often found enclosed in these pisolites of limonite.

NIGERIA

The Imperial Institute has received from the Director of the Geological Survey the following report on the work carried out in Nigeria during the second half of 1932.

Water Supply.—During the period under review the activities of the Geological Survey have been devoted almost entirely to water supply investigation and development. The main items of interest have been the discovery of subartesian water underlying Sokoto, and to the east of it and the use of geophysical prospecting methods in the search for water in the difficult area of Ishan, Benin Province. This work is not yet completed, but it seems likely that such methods of attack will be useful in crystalline country and in detecting "perched aquifers" in sediments.

Water supply operations have been continued with success in Sokoto, Bornu and Hadejia and have been extended to Katsina and Gumel Emirates. Several Native Administrations have asked for assistance in improving water supply as a check on water-borne disease, particularly guinea-worm and Bilharzia, which are to be found in all shallow, native wells.

In Sokoto, 36 shafts have been sunk in the half-year, mostly in the area south-west of Sokoto City. Here wells are shallow and the work has been directed mainly towards ameliorating present sources of supply which are foul and scanty. It is proposed to equip these wells with hand pumps and to close them in to prevent reinfection.

Water supply development in the north-western corner of Bornu Emirate has now been completed, at least for the present, and operations are being transferred early in the new year to central Bornu along the important trade route from Maiduguri to Nguru. This area, while containing ample fertile farmlands and excellent grazing, is sparsely inhabited, and it is hoped that provision of permanent water supplies will encourage settlement. The total number of shafts sunk to water in the last half year is 17.

The original two years' programme in the Hadejia Emirate is now completed. A total of 61 shafts has been constructed there. The work in that Emirate will now be slowed down, while the main effort in this area will be made in the adjoining Gumel Emirate where there are large areas of virgin bush which, were water provided, would attract settlers.

Geological investigation for water supply has been made in the Babura district of Kano Emirate and has shown that ample supplies of water, sometimes under pressure heads of as much as 100 ft., underlie that area and can be made available by the methods used in the other Emirates.

Mining.—The interest in gold still continues, and there

has been considerable pegging along the Zamfara valley in the Sokoto Province. The monthly output has remained fairly constant since the close of the rains, and this, combined with the interest taken by some of the larger tin-mining companies and with the attention being paid to the auriferous reefs, promises well for next year. A map and an account of the geology of the goldfield are being published in the near future.

General.—A start has been made with the detailed survey of that area in the Southern Provinces lying between the western railway and the Dahomey boundary.

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Some Properties and Applications of Timber By A H Loveless. *Chem and Indust* (1932, **51**, 1052–1054) Deals principally with the use of timber in the chemical industry

Moisture Content of Wood in Dwellings By E C Peck *Circ No 239 U S Dept Agric* Pp 24, 9 × 6 (Washington, D C Superintendent of Documents, Government Printing Office, 1932) Price 5 cents.

Calorific Values of some Indian Woods By S Krishna and S. Ramaswami *For Bull No 79, Chemistry Series For Res Inst, Dehra Dun* Pp 27, 9¾ × 7¼ (Calcutta Government of India Central Publication Branch, 1932) Price As 12 or 1*s* 3*d*

Modern Methods of Wood Preservation By G Gunn *Chem and Indust* (1932, **51**, 1072–1075)

The Preservative Treatment of Fence Posts, with Particular Reference to Western Australia By J E Cummins *Journ Dept Agric, W. Australia* (1932, **9**, 186–197, 394–408)

The Common Furniture Beetle *Leaflet No 8, For Prod Res Lab, Dept Sci Indust Res* Pp 5, 9¾ × 7¼ (London H M Stationery Office, 1932) An account of this pest, with suggested method of control.

Marketing and Industrial Uses of Charcoal By R S McBride. *Chem and Met. Eng* (1932, **39**, 664–667)

Gums and Resins

The Damars of the Malay Peninsula By T A Buckley *Malayan Forest Record No 11* Pp 94, 10¾ × 7¼ (Kuala Lumpur Director of Forestry, 1932) Price 1 50 Malayan dollars or 3*s*. 6*d*

Annual Report of the Indian Lac Research Institute for the year April 1, 1931 to March 31, 1932 Pp 44, 9¾ × 7¼ (Namkum, Ranchi. Lac Research Institute, 1932)

Indian Rosin and Turpentine By A J. Gibson *Oil and Colour Trades Journ* (1932, **82**, 1716–1718).

Tanning Materials

South African Tanning Materials. Part III. By C. O. Williams. *Sci. Bull. No. 106, Dept. Agric., Union of S. Africa.* Pp. 92, 9½ × 6. (Pretoria: Government Printer, 1932.) Price 1*s.* Deals mainly with the black wattle industry.

Report of the Sixth International Commission (Indian Section) on *Tanning Materials.* Work done in India on Tanning Materials up to May 1931. By B. M. Das and B. B. Dhavale. Pp. 4, 13¾ × 8½. Mimeographed copy.

Pine Bark Extract. Its Use and Effect. By S. A. Sagoschen. *Leather Trades' Rev.* (1932, **65**, 1512).

Annual Report of the Wattle and Timber Growers' Association presented at the Annual General Meeting, May 1932. Pp. 3, 13½ × 8½. (Pietermaritzburg: Wattle and Timber Growers' Association, 1932.)

The Wattle Bagworm (*Acanthopsyche junodi* Heyl.): an Ecological Study. By J. S. Henkel and A. W. Bayer. *South African Journ. Sci.* (1932, **29**, 355–365).

Possibilities of Combating Wattle Bagworm with Insecticidal Dusts. By L. B. Ripley and B. K. Petty. *South African Journ. Sci.* (1932, **29**, 544–561).

NOTICES OF RECENT LITERATURE

Books for review should be addressed to "The Editor," Bulletin of the Imperial Institute, South Kensington, London, S.W.7.

THE FARM AND THE NATION. By Sir E. John Russell, D.Sc., F.R.S. Pp. 240, 7¾ × 5¼. (London: George Allen & Unwin, Ltd., 1933.) Price 7*s.* 6*d.*

In this volume the Director of Rothamsted Experiment Station discusses the possibility of developing British agriculture for the welfare of the community, using it as a means of increasing the national wealth and of opening up work on the land for some of the unemployed.

The total food bill of Great Britain amounts to some £640 million. Home supplies and those from foreign countries are about equal, approximately £250 million each, whilst the overseas Empire countries contribute £140 million. The causes which have led to the present large dependence (60 per cent.) on imported foods, be they of Empire or foreign origin, are clearly traced as regards some of the more important products. Take the case of wheat. From about 1850 great improvements in British agriculture, such as manuring, the use of improved varieties and of more efficient farm implements, greatly encouraged wheat production, and round about 1870 the nation was as nearly self-supporting as was possible. Two important factors were, however, necessary: a price of about 50*s.* to 55*s.* a quarter (8 bushels or 504 lb.) and a

plentiful supply of good labour at 10*s.* to 12*s.* per week (often with certain perquisites). Then came cheaper wheat grown on a large scale in the United States and Canada, with the use of labour-saving machinery, efficiency being calculated in terms of output per man and not per acre. The wheat-producing area of North America was greatly increased when first " Red Fife " was found suited to the prairies, and later " Marquis " wheat to lands much farther north. Concurrently there was in Britain the great development of towns and the rise in wages, so that agricultural labourers could no longer be satisfied with their previous low earnings. Attention was then turned to meat, but scientific developments in the transport of perishable produce have made fresh meat also subject to overseas competition.

After chapters dealing broadly in an extremely interesting manner with such topics as our farming land and how we use it, the Empire as a source of food and the possibilities of increasing its supplies, some of the farmers' difficulties, and how can we use our land to better advantage, Sir John puts the question " What should be the purpose of British Agriculture ? " He indicates three possible objectives :

(1) To grow more food for the nation ; (2) to provide better wages and bigger profits for people working on the land, and so encourage others ; (3) to settle a larger population on the land. He points out, however, that these are quite distinct, any one may be aimed at with some chance of success, " but to aim at all three probably means missing them all."

This leads him to suggest three ways in which British agriculture can be treated :—(1) Organised for the production from our own soil of as much food as is practicable ; (2) organised for the provision of work for men displaced by modern methods and by machinery ; (3) left to struggle as best it may against unrestricted imports of food from overseas ; and to add : the choice must be made by the community and must be made soon.

THE H. E. A. YEAR BOOK, Volume I, 1932. Hon. Editor : R. T. Pearl, B.Sc., A.R.C.S., D.I.C. Pp. xi + 92, 9¾ × 6¼. (Wye : The Horticultural Education Association, 1932.) Price 3*s.* 6*d.*

The Horticultural Education Association has decided to publish a *Year Book* of which the volume under notice is the first issue. The attempt is made " to review the more important aspects of modern horticultural progress—

whether it be a problem of educational method, or some recent development in scientific investigation, or again an improvement in current horticultural practice."

A promising start has been made with a collection of articles by authors of recognised authority. Amongst the more important matters of general economic interest dealt with may be mentioned : Recent developments in relation to glass-house crops, by Dr. W. F. Bewley ; plant breeding at the Cambridge Horticultural Research Station, by D. Boyes ; the effect of orchard factors on the storage qualities of fruits, by Dr. T. Wallace ; the present uses and future development of spray spreaders, by H. Martin ; some new insecticides and possible insecticide-fungicide combinations, by Messrs. M. D. Austin, S. G. Jary and H. Martin.

Other articles deal with such subjects as county work in various parts of Great Britain, the cauliflower industry of Brittany, etc.

A HANDBOOK OF NYASALAND. Compiled by S. S. Murray. Pp. 436, $8\frac{3}{4} \times 5\frac{3}{4}$. (London : The Crown Agents for the Colonies. Zomba : The Government Printer, 1932.) Price 5*s*.

This authoritative work, one of the best official handbooks which have appeared in recent years, presents a comprehensive and readable survey of the Protectorate. History, government, agricultural and forest products, geology, climate and other matters are appropriately treated, and much information is given on the characteristics, languages and customs of the various native tribes. The book, which contains two maps and a number of full-page photographs, can be recommended to all readers interested in present conditions in Nyasaland or in the general question of colonial development in tropical Africa.

An index might usefully be added in any later edition of the Handbook.

A MANUAL OF THE FLOWERING PLANTS AND FERNS OF THE TRANSVAAL WITH SWAZILAND, SOUTH AFRICA. Part II. Malvaceæ to Umbelliferæ. By Joseph Burtt Davy. Pp. xxxv + 273–529, $7\frac{1}{2} \times 5\frac{1}{4}$. (London, New York, Toronto : Longmans, Green & Co., Ltd., 1932.) Price 25*s*.

The first Part of this work, which was published in 1926, dealt with the Pteridophyta, Gymnospermæ and Archichlamydeæ up to the Bombacaceæ. The Part now issued

completes the families included in the Archichlamydeæ. The arrangement is much the same as that of other of the "newer" floras, special attention being devoted to the keys which in the case of the larger genera give all the important characters of the species, the descriptions under the names of the species in such cases being restricted to a few distinguishing characters, the distribution, a list of specimens examined and so on. This method economises space, a consideration of much importance in view of the very large additions which have been made to the Transvaal flora in recent years. In this connection it is interesting to note that no less than 2,047 species and varieties are described in the two Parts of the Manual so far issued, as compared with 1,301 in the first check-list published in 1911.

The value of the Manual has been much enhanced through the co-operation of experts on certain genera, among whom may be mentioned Dr. N. E. Brown, who has elaborated the difficult genera *Thesium* and *Indigofera*, Mr. J. Hutchinson of Kew, and Mr. C. A. Smith and Miss I. C. Verdoorn of the National Herbarium, Pretoria. The subjects of the figures, of which there are 40 in this Part, have been selected with a view to illustrate as many families as possible (26 actually) and comprise in most cases trees and shrubs, so that they are of special value and assistance to Forest Officers. Notes on the local or commercial uses of the plants are given in appropriate cases.

International Institute of Agriculture, Rome. Bibliography of Tropical Agriculture, 1931. Pp. 70, 9¾ × 6¾. (Rome: Treves, Treccani, Tumminelli, S.A., 1932.) Price 10 lire.

Up to the end of 1930 a bibliography of tropical agriculture appeared in each number of the *Monthly Bulletin of Technical Information of the International Review of Agriculture* issued by the International Institute of Agriculture, Rome. For financial reasons the publication of the bibliography ceased, but fortunately it has been possible to issue the references covering the year 1931 in book form, through the generosity of His Excellency M. de Michelis, the Italian Delegate and President of the Institute. It is pointed out, however, that continued publication is possible only if the Institute can be assured that the sale will be sufficient to cover the cost, and it is therefore hoped that those interested in tropical agriculture, especially Government Departments, Experiment

Stations, Societies and kindred bodies, will respond to the appeal for an annual subscription.

The Bibliography forms a useful guide to current literature, the titles of articles in the more important journals, published in all parts of the world, being given, together with a few lines explaining their contents. The items are grouped in subjects and there is an index to authors.

Dizionario Pratico Degli Alimenti. By Dott. Ettore Santangelo. Pp. l + 408, 10 × 7. (Milan : Ulrico Hoepli, 1932.) Price 50 lire.

This work, written in Italian, consists mainly of a comprehensive and concisely arranged encyclopædia of foodstuffs and beverages, embracing not only those consumed by Europeans—inclusive of a number of proprietary foods, etc.—but many articles used mainly by natives of tropical regions. Apart from general descriptions, a great deal of instructive detail is provided, including botanical and zoological names, chemical composition, nutritive value, relative digestibility, etc. The wide scope of the work may be illustrated by mentioning that among the flesh foods dealt with are such exotic items as bustard, llama, marmot, polar bear, tapir, quagga, electric eel and hippopotamus. The volume also contains introductory notes on nutrition and alimentation, and at the end a series of detailed dietaries suitable for sufferers from certain specific diseases and other abnormal conditions of health.

The book has been compiled with great care, is printed in large, clear type, and should form a standard work of reference.

Le Coton en Afrique Tropicale. By Paul E. A. Janssens. Pp. 402, $9\frac{1}{2} \times 6\frac{1}{4}$. (Brussels : Ateliers R. Bausart, 1932.) Price 14 belgas.

This work deals with the position of cotton production in the various countries of Tropical Africa, with special reference to the methods of cultivating the crop and preparing it for the market.

In the preface, contributed by M. Edmond Leplae, Director-General of Agriculture to the Belgian Colonial Office, to whom the development of cotton-growing in the Belgian Congo is very largely due, it is mentioned that the author has lived and travelled in a great many cotton regions and has been able to study the crop in the British and Portuguese Colonies of Africa, in the Belgian Congo

and in Brazil, and that his object in writing the present volume was to provide a *vade mecum* of cotton in which could be readily found such data and information as might be required in the course of their work by colonists, agriculturists or commercial men. In preparing the material M. Janssens had the advantage of the collaboration of M. W. J. Lugard, a cotton specialist well known in the Belgian Congo.

After an introductory portion relating to the cultivation of the cotton plant, including the soil and climatic conditions required for its satisfactory growth, the author deals with marketing, selection, seed disinfection, costs of production, the pests and diseases by which the plant is liable to be attacked and the uses to which cotton and its by-products are applied. Reference is made to the British Cotton Growing Association and the Empire Cotton Growing Corporation, and to the work of the Association Coloniale Française.

An account is given of the cotton industry in the various European Dependencies in Africa, the countries being considered in the following order: *British:* Nigeria, Gambia, Gold Coast, Nyasaland, Uganda, Kenya, Guiana, Sierra Leone, Anglo-Egyptian Sudan, Tanganyika. *Belgian:* Belgian Congo. *French:* French Equatorial Africa, French West Africa. *Italian:* Italian Somaliland, Erythrea. *Portuguese:* Mozambique, Angola.

The book is well illustrated and will doubtless be very useful to all interested in the development of cotton growing in Africa.

THE METHODS OF CELLULOSE CHEMISTRY, including methods for the investigation of the compound celluloses. By Charles Dorée, M.A., D.Sc., F.I.C. Pp. x + 499, $8\frac{1}{2} \times 5\frac{1}{2}$. (London: Chapman & Hall, Ltd., 1933.) Price 21*s*.

This is a book which has long been needed. It contains in a well-arranged and convenient form detailed information on cellulose and its modifications and derivatives which has not hitherto been readily available but could only be obtained by consulting a wide range of literature. The work deals with the subject in a practical manner and will be most helpful to the student in giving him full experimental details and clear descriptions of analytical methods, and also to the research worker in indicating the source of the more important original communications on the subject and suggesting lines of research.

The book consists of three parts, the first dealing with

normal cellulose, its preparation and properties, the modifications, known as oxycellulose and hydrocellulose, and its various degradation products. The second part is concerned with the cellulose esters, including the nitrate, xanthate and acetate, and the cellulose ethers. The third, and perhaps to readers of this BULLETIN the most interesting, part of the book deals with the investigation of the compound celluloses and their occurrence in vegetable tissues, and includes methods of estimating cellulose, lignin, furfural, etc. It also devotes separate chapters to the hemicelluloses, the analysis of wood, the investigation of paper pulp and pulping processes, the chemistry of isolated lignin and the pectic substances. The book can be recommended to those interested in the chemistry of cellulose as well as to those engaged in all branches of the cellulose industries.

THE MANUFACTURE OF PAPER CONTAINERS. The Revised Text Book on Paper Box and Bag Making. By P. E. Verstone. Pp. 317, 9 × 6. (London: Verstone & Company, 1932.) Price 15*s*. 6*d*.

The first edition of this work was published in 1922. Since that time many improvements have been made in the methods of manufacturing paper containers, and new styles of packing in paper boxes and cartons have been introduced. In view of the desirability of recording these various advances the book has been thoroughly revised and much of it rewritten.

The volume is intended for practical use in the factory and is therefore primarily concerned with manufacturing operations and the machinery employed. The machine-made paper boxes are classed in five groups, viz. the upright covered box, which is rigid and held together by means of adhesives only; the folding box, or carton, which can be stored in a flat condition when not in use and is held together by means of adhesives; the upright wire-stitched box, which is rigid and held together by means of wire pierced through the cardboard; the collapsible wire-stitched or taped box, which folds flat when empty and is held together by wire or gummed tape, or both; and the round box, which is rigid, but of cylindrical or conical shape and held together by adhesives. Hand-made boxes are dealt with under the headings of the square-edged or rectangular, the round or oval, and the fancy-shaped. Consideration is also given to the many kinds of paper bags, both hand- and machine-made. Certain chapters are devoted to the raw materials used in paper box and

bag manufacture, and to the auxiliary materials, such as adhesives, stitching wires, and waterproofing substances.

The book is well illustrated and the revised edition will doubtless be welcomed by makers of paper containers of all kinds.

ANIMAL INDUSTRY IN THE BRITISH EMPIRE. By A. N. Duckham, M.A. Pp. xvi + 239, $8\frac{1}{2} \times 5\frac{1}{2}$. (London: Humphrey Milford, Oxford University Press, 1932.) Price 15*s*.

This book is described in a sub-title as "a brief review of the significance, methods, problems and potentialities of the live-stock and dairying industries of the British Commonwealth." It consists of a survey of animal husbandry within the Empire, prepared by the author on behalf of the Imperial Bureau of Animal Nutrition at the Rowett Research Institute, Aberdeen, and, as explained in a Foreword by Dr. J. B. Orr of the Rowett Institute, its publication should assist Government Departments and other bodies in considering the various problems of the animal industry with which they have to deal. It is also hoped that the volume will be of interest to producers, traders, economists and others concerned with schemes for inter-Imperial trade.

In carrying out his research the author had in mind the following principal aspects of the subject: (*a*) the economic significance of animal industry to the British Empire and to each of its constituent countries; (*b*) the methods employed in the production of live-stock and animal products in each principal Empire country, in relation to geographical, economic and other conditions; (*c*) the efficiency of land, animal and labour utilisation in the chief Empire countries; (*d*) the problems limiting increase in "economic" production, and the steps being taken to overcome them.

Two chapters of the book are devoted to "The British Isles," one to "Canada and Newfoundland," two to "Australia and New Zealand," and one to "South Africa." India and the Colonial Empire are relegated to an Appendix, owing, as explained in the Preface, to the fact that there is no immediate likelihood of any greatly increased output of animal products in these countries and because in the Tropics, social and other factors, outside the province of the present work, have considerable bearing on the problem of the industry.

The subject-matter is systematically arranged and clearly presented, and as a survey of current conditions and

possible future developments it may usefully be perused by all concerned with the animal husbandry of the Empire.

CATTLE FARMING IN SOUTH AFRICA. By A. M. Bosman. Pp. 458, $8\frac{1}{2} \times 5\frac{1}{2}$. (South Africa: Central News Agency, Ltd.; London: Gordon & Gotch, Ltd., 1932.) Price *27s. 6d.*

South Africa is predominantly a pastoral country, and its development must depend largely on its farmers and their capacity to make the best of the conditions prevailing there. These conditions differ in many respects from those of pastoral countries in general, and Professor Bosman's book, which is issued as No. 10 of the "South African Agricultural Series," has been written with the object of affording guidance where books on farming written for other countries would be misleading. It is practical rather than academic in outlook, and on some subjects, such as genetics, it is, to quote the Preface, "purposely unorthodox."

The first part consists of two chapters dealing with the beef and dairy industries, the former having an "addendum" in which Mr. John Todd, a well-known South African cattle farmer, discusses a number of matters affecting the future of the pastoral industry in the Union.

Part II is concerned with the principles of breeding. It introduces the reader to fundamental biological theories, to cell division and other processes involved in reproduction and development, to the laws of Galton and Mendel, and to the nature and causes of variation. Certain matters of common belief among breeders are discussed, such as prepotency and telegony. There is a chapter on selection and finally one on systems of breeding, the latter differentiating between systems having as their ultimate object the improvement of the breed and those aiming only at herd improvement with the commercial value of the animal as sole criterion.

Part III, under the heading "Feeds and Feeding," contains chapters on the principles of nutrition, the uses and feeding values of particular feeding stuffs, feeding standards and the computation of rations, and questions of costs in relation to the selection of feeds.

Part IV deals with the care and management of cattle for beef and dairy purposes and with veld and pasture management.

The fifth Part contains chapters on the Africander breed and its characteristics, the trek ox, the preparation

of cattle for shows, and the production and handling of milk and cream. There are a number of appendixes giving tabular information regarding feeding stuffs, particulars of regulations relating to dairies, dairy cattle improvement and milk recording, and a key to the earmarking of stud cattle.

The book is likely to prove of very considerable value to all who are concerned with farming in the Union, either as practical farmers or otherwise.

Animal Diseases in South Africa. By M. W. Henning. 2 Volumes. Pp. xxi + 878, 9 × 6. (South Africa: Central News Agency, Ltd.; London: Gordon & Gotch, Ltd., 1932.) Price 50*s*.

This book, comprising Volumes 11 and 12 of the "South African Agricultural Series," will be welcomed as a work of reference, not only by veterinarians but also by farmers and by all who have any concern with animals in the Union. The author, who is Professor of Veterinary Science at the University of Pretoria, has brought together information from a large number of sources relating to the diseases that affect farm animals in South Africa, and their incidence, diagnosis, treatment and prevention. A very useful section of the book, forming about half the second volume, deals with poisonous plants and their effects on animals, a matter of considerable importance in the Union.

College Geography. By Earl C. Case and Daniel R. Bergsmark. Pp. xiii + 700, 9 × 6. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1932.) Price 28*s*.

The authors of this volume are respectively Professor and Assistant Professor of Geography at the University of Cincinnati, and have compiled the work "to meet the need of an increasing number of departments of geography in universities, colleges and normal schools which are emphasising the regional and economic phases of the subject." The contents are thus mainly of a formally instructional nature, but they are attractively arranged, and include a great deal of useful information likely to appeal to the general reader interested in physical and commercial geography. The volume is copiously furnished with bibliographies, maps, diagrams and illustrations.

THE FORM AND PROPERTIES OF CRYSTALS. By A. B. Dale, M.A. Pp. x + 185, 7½ × 5. (Cambridge: The University Press, 1932.) Price *6s.*

In writing this little book the author has set herself the task of producing a concise and inexpensive text-book describing the principles upon which the examination and identification of minerals is based, suited to the needs of those who possess an elementary knowledge of physics and mathematics. Throughout the book, care has been taken to make the text as simple as possible.

It begins with a discussion on the nature of crystals introducing the law of the constancy of crystal angles and the methods of measuring them; symmetry; the law of rational indices and the Millerian system of notation. The methods for drawing crystals are also described and the stereogram is carefully explained. In the following chapter the classification of crystals into seven systems and thirty-two classes is dealt with, and a tabular statement of the crystal systems is printed as an end-paper to the book. This chapter contains one of the most useful features of the work in the form of three simple practical examples of the construction and use of stereographic projections of crystals. A few pages are then devoted to the internal structure of crystals and contain a brief mention of the recent discoveries in atomic structure revealed by X-ray methods. Then follows a short account of the general physical properties of crystals such as twinning, cleavage, hardness, specific gravity, etc.

The latter half of the book consists of two long chapters, on the optical properties of minerals and the methods of investigating them by means of the petrological microscope. The treatment of the subject is necessarily brief, but adequate for the purpose.

The book has obviously been carefully prepared and although it contains a number of statements which are open to criticism, there seem to be few definite errors like the statement on page 93 that talc is an amphibole.

It is a handy little book for students, which should serve a useful purpose.

A FRENCH-ENGLISH VOCABULARY IN GEOLOGY AND PHYSICAL GEOGRAPHY. By G. M. Davies, M.Sc., F.G.S. Pp. ix + 140, 7¼ × 4¾. (London: Thomas Murby & Co., 1932.) Price *6s.*

Some years ago, the author compiled a thumb-indexed notebook in which unfamiliar French geological words were entered. This index was considerably extended

from time to time and now appears as a handy French-English vocabulary containing upwards of 5,000 references to geological and allied terms. In order to keep the work as brief as possible, all words that differ but little from their English equivalents have been omitted, while it has not been thought necessary to give all the derivatives from common French roots. Two appendixes have been included, the first of which is a tabular statement of stratigraphical terms of more than local application, with indications as to their approximate English equivalents, while the second is a collection of conversion factors relating to weights and measures.

The book is yet another of the useful geological series published by Thomas Murby & Co., and will doubtless prove of value to readers of French works on geology and its associated sciences of physical geography, mineralogy, petrology, palæontology, stratigraphy and mining.

FLOTATION PLANT PRACTICE. By Philip Rabone, A.R.S.M., D.I.C., Assoc.Inst.M.M. Pp. xi + 141, 9 × 6. (London: Mining Publications Ltd., 1932.) Price 10*s.* 6*d.*

In the preface the author states that this book is based on lectures, which were designed to give the engineer and student a broad conception of the subject. The object has been achieved and the book forms a comprehensive introduction to flotation practice. Descriptions of specific practices are avoided, but details are given which should prove a valuable guide to the procedure to be adopted for a particular ore.

A rather large part of the book is devoted to crushing and grinding, but this section is well written and comparisons are drawn clearly and without overburdening the text with figures. A description follows of the reagents employed in flotation practice, together with definitions and a short statement of the theory of flotation. The chapter on flotation machines gives descriptions of four representative machines together with methods of operating and concludes with a dissertation on the choice of machine and some notes on the Roots type of blower.

The chapter on flotation methods which follows occupies only twenty-one pages but brings out forcibly the simplicity of flotation methods and the importance of operating details. The last two pages of this chapter deal with costs, but the chapter is far too brief. Thickening and filtering of the final products are described in the last chapter and there is an appendix indicating the capital cost of flotation plants.

This book should be very popular, as it contains much essential information in a not too highly specialised form.

TIN SOLDERS: A MODERN STUDY OF THE PROPERTIES OF TIN SOLDERS AND SOLDERED JOINTS. By S. J. Nightingale. Pp. viii + 89, $7\frac{1}{2} \times 5$. (London: The British Non-Ferrous Metals Research Association, 1932.) Price 5s.

This excellent little book on tin solders is essentially a popular supplement to the author's more detailed and technical report on soft solders and soldered joints, issued as Report No. 41 of the British Non-Ferrous Metals Research Association. It presents, in simple and concise form, the main results of Mr. Nightingale's investigations carried out with the co-operation of Metropolitan-Vickers Electrical Co., Ltd., of Manchester, and Capper Pass & Son, Ltd., of Bristol. The importance of these investigations can be judged from the fact that they have already proved of value to industry as forming a basis for the first standardisation of solders by the British Standards Institution.

The present work is divided into two parts, Part I dealing with the properties of tin solders and strength of soldered joints, and Part II with practical considerations regarding fluxes, wiped joints, choice of solder and other important problems. The work is well presented, and the beautifully reproduced photomicrographs and diagrams are, for the most part, self-explanatory.

In these days when solder is a most important and expensive industrial material, any publication that makes for improved solder or soldered joints is justifiable, and in this connection the present work is particularly welcome. Although designed primarily for those who use solder, such as plumbers, tinsmiths and cable jointers, this book should nevertheless prove of interest to both manufacturers and dealers.

DER MAGNESIT UND SEINE VERARBEITUNG. By Dipl.-Ing. R. Banco. Technische Fortschriftsberichte, Band XXVIII. Pp. 64, $8\frac{3}{4} \times 6$. (Dresden and Leipzig: Verlag von Theodor Steinkopff, 1932.) Price RM. 5.

This publication is number twenty-eight in a series of illustrated handbooks intended to record the technical progress of various industries. It contains a broad survey of the present practice in the trade, the development of which is described only as an explanation of the methods now employed, e.g. to show the trend in kiln design.

Crude magnesite and its preparation are briefly described in four pages; slightly less space is devoted to caustic magnesite, the preparation of which is dealt with chiefly by reference to methods (described later in the book) for the manufacture of the dead-burnt material. A discussion on the effect of temperature and pressure is included and a description is given of the preparation of Sorel cement together with its use in patent floors. Other interesting uses of caustic magnesite are also included.

The next twenty-six pages deal with dead-burnt magnesite. The processes of dead-burning are described and compared, while the development of the shaft-kiln and the grinding of the final product are treated at some length.

An account of the manufacture and use of magnesite bricks occupies the remainder of the book, with the exception of a section of six pages on the microstructure of magnesite rock. The book concludes with a useful bibliography containing sixty-one references, of which thirty-two are to articles in English.

A Concise Building Encyclopædia—Illustrated. Compiled by T. Corkhill, M.I.Struct.E. Pp. 237, $7\frac{1}{2} \times 5$. (London: Sir Isaac Pitman & Sons, Ltd., 1932.) Price *7s. 6d.*

This little book is said to contain some 7,000 definitions and explanations of terms used in building and allied trades. It would perhaps be better described as an illustrated dictionary, rather than an encyclopædia, as the information is highly condensed and the definitions are short.

Those whose professional interests are even remotely connected with building will find the explanations which are given of technical terms extremely useful, while the householder, with its aid, will find that he is better able to interpret the meaning of building specifications, and of reports and estimates by decorators, carpenters, plumbers, etc., who, in common with their more strictly scientific brethren, often assume that the layman is acquainted with the meaning of their own particular "jargon."

Chemical Analysis by X-rays and its Applications. By Georg von Hevesy. Pp. 333, 9×6. (London: McGraw-Hill Publishing Co., Ltd., 1932.) Price 18*s*.

Lectures delivered by the holders of the George Fisher Baker Non-Resident Lectureship in Chemistry at Cornell University, who are all experts of international repute in

some specialised branch of chemistry, are being published as a series of monographs. The present volume is the tenth of the series and contains the lectures delivered by Professor G. von Hevesy. The subject is treated very broadly and contains much of general interest to both chemist and geologist.

The first part of the book includes an introductory lecture giving a short account of methods which have been employed for estimating the age of the earth and the significance of the results obtained. This is followed by lectures dealing more particularly with the theory and practice of X-ray analysis and examples of its uses. Of particular interest is a chapter describing the use of X-ray methods in the analysis of the complex mineral thucolite, a complete chemical analysis of which would demand great skill and entail a considerable amount of work. The X-ray spectra, however, rapidly revealed the presence of twenty-three elements which could be quantitatively determined by the intensities of the characteristic lines obtained.

The second part deals with the discovery and properties of hafnium, whose occurrence was first definitely proved by X-ray methods. Hafnium always accompanies zirconium in nature, the two being present, with but few exceptions, in the approximate ratio of 60 parts of zirconium to one part of hafnium. The fact that the isolation of hafnium from zirconium is of such recent date is sufficient evidence of the extreme similarity in the chemical behaviour of the two elements. Satisfactory, although lengthy, chemical methods of separation of zirconium and hafnium have now been worked out and hafnium compounds are being prepared on a commercial scale in Germany, although they do not appear as yet to have any important applications.

The final section contains a general account of the chemical composition of the earth. A number of exhaustive analyses of representative rock mixtures and various types of meteorites, using combined chemical and X-ray methods, have been carried out and the significance of these results is discussed. This information, supplemented by a study of the solar and stellar spectra, enables an estimate to be made of the cosmic abundance of the elements, which is of value in assisting to elucidate the problem of the structure of the atomic nucleus, as the relative abundance of the elements is a measure of their respective nuclear stabilities.

X-ray spectroscopy should play an increasingly important part in geochemical research. For the detection

of the elements of low atomic number it is, however, not as sensitive as optical spectroscopy, and the expensive apparatus, combined with the technical skill required, prohibits its use in mineral analyses, unless it is required to determine minor constituents present only in very small amounts.

Professor von Hevesy has a breadth of outlook seldom found in modern scientific experts and this book is of great interest as an account at first-hand of a most important piece of pioneer work.

Kingzett's Chemical Encyclopædia. A Digest of Chemistry and its Industrial Applications. By C. T. Kingzett, F.I.C., F.C.S. Fifth Edition. Pp. viii + 1014, 9 × 6. (London: Baillière, Tindall & Cox, 1932.) Price 40*s*.

In his preface to this edition, the author states that, apart from its value to those interested in applied chemistry, he hopes it will secure greater use by politicians, journalists and other sections of the professional and cultured classes. He further states that after meticulous revision it has " upwards of 200 more pages than its predecessor, and it is up to date so far as such a work can be kept while going through the press." A glance through its pages, however, shows that it contains much that is erroneous and out of date.

Under the heading " Abrasives " it is stated that " silicon carbide, corundum and corundite are found in South Africa." Of these three, however, corundum is the only natural mineral, the other two being artificial products.

The chief sources of cobalt are stated to be Canada and Queensland, no mention being made of the Belgian Congo, the chief producer.

Talc is stated to be used for " making stove windows, goggles, lamp chimneys or phonograph diaphragms," which statement shows that the author has confused the uses of this mineral with those of mica.

" Rasorite " is defined as " an American mineral hydrated sodium borate *made* in the Kramer district *near* California," but under " Boron " no mention is made of the fact that this substance (which is not " made," but occurs as a mineral, alternatively named kernite, in Kern County, California) is the chief source of the world's supply of borates at the present time. The name kernite is not given.

Among non-mineral products which are treated in a

similarly confusing manner may be mentioned Alfalfa, which, though correctly shown to be the same as lucerne, is incorrectly described as *Stipa tenacissima* and equally erroneously alleged to be used for the same purposes as the latter (esparto). Corresponding confusion occurs under the heading "Esparto" itself. American wormseed (*Chenopodium ambrosioides*) is confused with true worm-seed (*Artemisia* sp.), whilst the dyewood *Pterocarpus santalinus* is included with *Santalum album* under the heading "Sandal Wood (Santal Wood)."

The entry "Arghan" is misleading, since fibre under this name is not being produced commercially and the company exploiting it went into liquidation some years ago.

Perilla oil is referred to as an essential oil; Persian berries as the dried bark of *Rhamnus frangula*; Valonia as the product of *Quercus robur* and *Q. suber*, as well as of *Q. ægilops*; Bourbon geranium oil as the product of *Andropogon schœnanthus*; and the Bokoby oil of Madagascar (*Aleurites moluccana*) is called Tung oil.

Instances such as those mentioned above could be multiplied at great length. They are referred to here, not in a mood of mere carping criticism, but rather to indicate the need for still further serious revision if a later edition is to attain the degree of accuracy that is necessary in a reference book of this type.

BOOKS RECEIVED FOR NOTICE

WORLD AGRICULTURE. AN INTERNATIONAL SURVEY. A Report by a Study Group of Members of the Royal Institute of International Affairs. Pp. vi + 314, 9½ × 6½. (London: Mr. Humphrey Milford, Oxford University Press, 1932.) Price 12*s*. 6*d*.

WEST AFRICAN AGRICULTURE. By O. T. Faulkner, C.M.G., B.A., and J. R. Mackie, M.C., B.Sc. Pp. viii + 168, 8¾ × 5¾. (Cambridge: The University Press, 1933.) Price 8*s*. 6*d*.

THE SOUTH AND EAST AFRICAN YEAR BOOK AND GUIDE FOR 1933. Edited for the Union-Castle Mail Steamship Company, Ltd., by A. Samler Brown, F.R.Met.S., and G. Gordon Brown, F.R.G.S. Pp. lx + 1116, 7 × 4¾. (London: Sampson Low, Marston & Co., Ltd., 1932.) Price 2*s*. 6*d*.

Spices and Condiments. By H. Stanley Redgrove, B.Sc., F.I.C. Pp. xviii + 353, $8\frac{1}{2} \times 5\frac{1}{2}$. (London: Sir Isaac Pitman & Sons, Ltd., 1933.) Price 15*s*.

Rubber Latex. By Henry P. Stevens, M.A., Ph.D., F.I.C., and W. H. Stevens, A.R.C.Sc., A.I.C. Pp. 156, $8\frac{1}{2} \times 5\frac{1}{2}$. Second Edition. (London: The Rubber Growers' Association, Inc., 1933.)

Report of the Forest Products Research Board for the Year 1931. Department of Scientific and Industrial Research. Pp. vii + 51, $9\frac{3}{4} \times 7\frac{1}{4}$. (London: His Majesty's Stationery Office, 1932.) Price 3*s*. 6*d*.

Commercial Timbers of India: Their Distribution, Supplies, Anatomical Structure, Physical and Mechanical Properties and Uses. By R. S. Pearson, C.I.E., F.L.S., and H. P. Brown, Ph.D. Volume I, pp. xliv + 548; Volume II, pp. ix + 549-1150, $10\frac{3}{4} \times 7\frac{1}{2}$. (Calcutta: Government of India Central Publication Branch, 1932.) Price £5.

Transactions of the Bose Research Institute, Calcutta. Vol. VII, 1931–32. Edited by Sir Jagadis Chunder Bose, M.A., D.Sc., LL.D., F.R.S., C.S.I., C.I.E. Pp. vi + 343, $8\frac{3}{4} \times 5\frac{3}{4}$. (London, New York and Toronto: Longmans, Green & Co., Ltd., 1933.) Price 25s.

An Introduction to Tropical Soils. By Dr. P. Vageler, translated by Dr. H. Greene. Pp. xvi + 240, $8\frac{3}{4} \times 5\frac{3}{4}$. (London: Macmillan & Co., Ltd., 1933.) Price 15*s*.

Observations Géologiques dans la Partie Méridionale de l'Afrique Equatoriale Française. By Dr. V. Babet. Pp. viii + 154, $11 \times 7\frac{1}{2}$. (Paris: Larose, 1932.)

Metamorphism. A Study of the Transformations of Rock-Masses. By Alfred Harker, M.A., LL.D., F.R.S. Pp. ix + 360, $9 \times 5\frac{3}{4}$. (London: Methuen & Co., Ltd., 1932.) Price 17*s*. 6*d*.

Lubricating and Allied Oils. A Handbook for Chemists, Engineers and Students. By Elliott A. Evans, F.C.S., M.I.P.T. Pp. xv + 175, $8\frac{3}{4} \times 5\frac{3}{4}$. Second Edition, Revised and Enlarged. (London: Chapman & Hall, Ltd., 1933.) Price 9*s*. 6*d*.

REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

Selected from the Reports made to the Dominion, Colonial and Indian Governments

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SUNN HEMP FROM UGANDA

REFERENCE has already been made in this BULLETIN (1931, **29**, 472; 1932, **30**, 219) to the experiments in the production of sunn hemp (*Crotalaria juncea*), which are being carried out by the Department of Agriculture at the Serere Experiment Station, Uganda, whilst last season's work is dealt with on p. 264 of this issue. Seed was first introduced to the Station towards the close of 1930 from the Bukalasa Station, Uganda, whilst samples of Indian seed were subsequently obtained from Nagpur and Cawnpore.

Sufficient of the Bukalasa seed was obtained to plant a total of 2½ acres. Sowing took place on April 15, 1931, at rates of 40 lb., 50 lb. and 60 lb. per acre; four repetitions were made of each of the two lower rates and three of the higher one. The seed germinated rapidly, mostly within three days of sowing, and the plants reached the flowering stage well within six weeks. The growth during this period was very variable, the height ranging from 2 feet to 4½ feet at the time of first flowering, and so showing up soil variation rather well. At the end of June, plants were flowering very profusely.

An experiment with a seed rate of 90 lb. per acre was also made, the seed being sown a little later, in May.

The plants raised from both the Nagpur and the Cawnpore seed were much smaller and less vigorous than those from the acclimatised seed from Bukalasa. Both types, however, are being grown for increase of stock and subsequent selection.

Three main rettings of the 40-, 50- and 60-lb. seed rates of the Bukalasa strain were made during the season, corresponding to the various stages of the plants' growth. The first, made during the early flowering period (54 days from the sowing date), gave a very poor result ; the yield was estimated at only 20 lb. of fibre per acre and the product was of very poor quality. The second, at the early fruiting period (108 days from sowing), gave approximately 200 lb. per acre of fibre of improved quality, whilst the third cutting, made at the stage when the fruits were ripe (140 days from sowing) gave a slightly higher yield.

Rettings were also made from material grown from the seed rate of 90 lb. per acre. The results were better both as regards length and quantity of fibre. The best yield from any one retting was calculated at 476 lb. per acre, the fibre being fully 6½ ft. in length.

The two main conclusions reached as a result of this first season's cultivation were : (1) that a heavier seed rate is necessary to obtain fibre of good length and (2) that more fibre is obtained from the stems when approaching maturity.

Twenty-six samples representing the fibre obtained in the course of these trials at Serere were forwarded to the Imperial Institute in February 1932. It was desired to ascertain (*a*) the quality and value of the samples in comparison with standard grades of Indian sunn hemp, and (*b*) which of the various combinations of treatment had yielded the best fibre.

The following table gives the particulars regarding growth and preparation furnished by the Director of Agriculture.

Sample No	Weight of Sample	Seed Rate	Days' Growth	Conditions of Preparation
	lb	lb per acre		
1	1½	40	108	Stripped wet after 3 days' retting
2	2	40	108	Stripped on third day after 3 days' retting
3	2	40	108	Stripped wet after 5 days' retting
4	2½	40	108	Stripped on third day after 5 days' retting
5	2	40	108	7 days' retting
6	1½	50	108	Stripped wet after 3 days' retting
7	4	50	108	Stripped on third day after 3 days' retting
8	2	50	108	Stripped wet after 5 days' retting
9	2½	50	108	Stripped on third day after 5 days retting
10	2	50	108	7 days' retting
11	2	60	108	Stripped wet after 3 days' retting
12	3	60	108	Stripped on third day after 3 days retting
13	2	60	108	Stripped wet after 5 days' retting
14	3	60	108	Stripped on third day after 5 days' retting
15	2½	60	108	7 days' retting
16	4	40	140	3 ,, ,,
17	3½	40	140	5 ,, ,,
18	5	50	140	3 ,, ,,
19	4	50	140	5 ,, ,,
20	4½	60	140	3 ,, ,,
21	3½	60	140	5 ,, ,,
22	14	90	140	3½ ,,
23	14	90	157	3 ,, ,,
24	14	90	157	3½ ,, ,,
25	14	90	164	3½ ,, ,,
26	24	50	—	(Bulk sample from 50 lb seed rate)

Results of Examination

Length —The following table shows the length of fibre in the various samples as determined at the Imperial Institute :

Sample No	Days' Growth	Seed Rate	Length in ft: Range	Length in ft: Mostly	Sample No	Days Growth	Seed Rate	Length in ft: Range	Length in ft: Mostly
		lb per acre					lb per acre		
1	108	40	2½–5	3–4	14	108	60	2½–5½	3½–4
2	108	40	2½–5	3½	15	108	60	2½–5	4
3	108	40	3–5½	4	16	140	40	3–5½	3½–4
4	108	40	3–5	4	17	140	40	3–5½	4–4½
5	108	40	2½–5	3½	18	140	50	2½–5½	4–5
6	108	50	2½–5	3½	19	140	50	3–5½	4–5
7	108	50	3–6	4–5	20	140	60	2½–6	4–5
8	108	50	3–5	4	21	140	60	3–6	4–5½
9	108	50	2½–5	3–4	22	140	90	3½–6½	5½–6
10	108	50	2½–5	3½	23	157	90	4–7	5½–6
11	108	60	2½–5	3	24	157	90	4–7	5½–6
12	108	60	3½–5	4	25	164	90	4–7	5½–6
13	108	60	3–5	4	26	—	50	3½–6	5–5½

Classification by Seed Rate.—The samples are classified below according to their respective seed rates, and a general description is given of the appearance of the fibre in each group.

Seed Rate. lb. per acre.	Sample No.	Description.
40	1	Fairly fine, rather matted fibre, of uneven colour and generally inclined to be towy.
40	2	
40	3	
40	4	
40	5	
40	16	
40	17	
50	6	Similar to the above.
50	7	
50	8	
50	9	
50	10	
50	18	
50	19	
50	26	
60	11	With the exception of Nos. 11 and 21, which were rather matted and dark in colour, these samples were fine and possessed fair lustre. The fibre had been generally well separated and was free from stick and extraneous matter. It was of rather better colour than the fibre from the 40-lb. and 50-lb. seed rates described above.
60	12	
60	13	
60	14	
60	15	
60	20	
60	21	
90	22	Fairly fine, rather matted fibre, of uniform colour.
90	23	
90	24	
90	25	

Classification by Retting Periods.—It was found that when the samples were grouped according to their retting periods several characters were common to the samples in each group. The following table gives a description of the fibres when classified in this manner.

No.	Seed Rate.	Colour.	Lustre.	Handle.	Preparation.	Strength.
	lb. per acre.					
			3 days' retting.			
16	40	Pale greyish-brown to yellowish-brown; some almost black fibre present.	Very poor	Harsh.	Rather matted, fairly fine fibre, of poor and variable colour Most of the fibre had not been sufficiently separated from gum, and much short and wasty fibre was present.	Rather weak.
18	50	do.	do.	do.	do.	Fairly good, but some weak.
20	60	do.	do	do	do.	Rather weak.
23	90	Pale greyish-brown.	Poor.	do.	Rather matted, some of it coarse Short wasty fibre present.	Some weak, but generally good.
			3½ days' retting.			
22	90	Very pale greyish-brown	Poor	Rather soft.	Mostly rather gummy, fairly fine fibre, free from bark A rather large amount of short and broken fibre present, and towy at the tips.	Generally good; some weak fibre present.
24	90	do.	do	do.	do.	do.
25	90	do.	do.	do.	do.	do.
			5 days' retting.			
17	40	Pale greyish-brown to pale yellowish-brown.	Fair	Soft.	Clean, but rather matted fibre, free from gum and bark A fair amount of short and towy fibre was present	Mixed, good to very weak.
19	50	do	do	do.	do	do.
21	60	do.	do.	do.	do.	do.
			7 days' retting.			
5	40	Pale greyish-brown to pale yellowish-brown.	Fair	Very soft	Similar to the fibre from 5 days' retting, but rather more short and towy fibre present	Irregular. Some very weak fibre present.
10	50	do	do	do	do.	do.
15	60	do.	do.	do.	do.	do.
			Stripped wet after 3 days' retting.			
1	40	Dark greyish-brown to pale brown	Fair.	Harsh.	Rather coarse unseparated gummy ribbons, not properly freed from bark. Some of the fibre short and towy	On the whole good, but some weak fibre present.
6	50	do.	do.	do	do.	do.
11	60	do.	do.	do	do.	do.

No	Seed Rate. *lb per acre*	Colour	Lustre	Handle.	Preparation.	Strength.
			Stripped wet after 5 days' retting.			
	40	Greyish-brown to pale yellowish brown.	Fair	Rather harsh	Generally coarse, rather matted, unseparated ribbons A small proportion of the fibre had not been freed from gum and bark Some towy fibre present	Mostly fairly good.
8	50	do	do	do	do	Fairly good; some weak.
13	60	do	Poor	do	do	Fairly good.
			Stripped on 3rd day after 3 days' retting.			
2	40	Greyish-brown to very dark greyish-brown	Poor	Harsh	Hard, matted, unseparated ribbons, not freed from gum and bark, and mixed with short towy fibre	Fairly good
7	50	do	do	do	do	do
12	60	do	do	do	do	do
			Stripped on 3rd day after 5 days' retting.			
4	40	Generally pale greyish-brown	Fair	Rather soft.	Mixture of somewhat coarse and fine fibre, rather matted in places Not properly freed from gum and bark	Fairly good
9	50	do	Poor	do	do	do
14	60	do	do	do	do	Good
26	50	Greyish-brown	do	Rather soft	Fairly fine, well separated and generally free from gum and bark	Fairly good

Composition.—The samples representing a 60-lb seed rate (viz. Nos 11–15, 20 and 21) were generally slightly superior in colour and appearance to the other samples and were accordingly selected for analysis Representative portions of the samples, as received, gave the following results :

	108 days' growth					14[illegible] days' growth	
Sample No	11	12	13	14	15	20	21
Retting Period (days) .	3	3	5	5	7	3	5
	Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Moisture .	9·7	9·5	9·5	9·0	9·3	8·9	9·6
Expressed on the moisture-free fibre							
Ash	1·4	1·8	1·5	3·2	1·2	1·9	0·9
α-Hydrolysis, loss .	10·8	12·8	12·0	14·7	11·8	12·0	10·4
β-Hydrolysis, loss .	18·5	23·0	17·4	19·6	16·4	19·8	17·9
Water-washing, loss .	2·3	3·2	2·0	2·9	3·3	2·3	2·0
Cellulose . .	80·8	79·4	84·2	72·0	82·9	84·1	85·2

The figures obtained for most of the seven samples compare very well with those for some of the better samples of sunn hemp from India examined at the Imperial Institute. Samples 13 and 21, retted for 5 days, contained the highest percentages of cellulose, and, like most of the five other samples, sustained fairly low losses on hydrolysis and on washing with water. Samples 12 and 14, retted for 3 and 5 days respectively and then kept 3 days before preparing the fibre, contained the lowest amounts of cellulose.

Remarks

The results of the examination of these 26 samples of sunn hemp afford no clear indication as to which combination of seed rate per acre, period of growth and retting treatment has proved the most satisfactory.

In order to draw any possible conclusions from the results of the experiments regarding the effect of each of these three factors separately, careful comparison has been made between samples in the production of which only one factor had varied.

Seed Rates.—With regard to the effect of the different seed rates, the groups Nos. 1, 6, 11; Nos. 2, 7, 12; Nos. 3, 8, 13, etc., vary only in this factor, and consideration of the results appears to indicate that, while there was no marked difference in the general character of the samples according to the seed rate, the rate of 60 lb. per acre had on the whole proved the most satisfactory. The products representing the 60-lb. seed rate were generally slightly superior in colour and appearance to the other samples.

Period of Growth. Similar comparative examination was made of samples in the production of which the period of growth was the only variable factor. Several of the samples of 108 days' growth contained some rather short fibre, but otherwise they were not inferior to the samples representing the longer periods of growth. Apart from possible differences in the yield of fibre per acre, there would seem to be no obvious advantage in the longer periods of growth.

Retting Treatment.—Comparisons of the same kind were made of samples in which the only variable factor was the retting period. Greater differences were produced by

variation in the period of retting than by variation in the seed rate or period of growth. Most of the samples retted for 3 or 3½ days were rather gummy and apparently somewhat under-retted, whilst those retted for 5 days were generally freer from gummy matter and more satisfactory. In the case of the samples retted for 7 days, some deterioration had taken place, the fibre mostly being rather weak and somewhat towy. It would appear that with 7 days' retting there is some danger of the strength of the fibre being adversely affected, and on the whole a 5 days' retting period may prove to be the most suitable for adoption.

It was observed that the fibre which had been stripped immediately after retting (for periods of either 3 or 5 days) was softer, of better colour and more effectively separated than that which had been stripped on the 3rd day after retting. The six samples (Nos. 2, 4, 7, 9, 12 and 14), the preparation of which had been deferred until 3 days after retting, had evidently suffered some deterioration from the delay, as was indicated both by their general appearance and the results of the chemical examination of Nos. 12 and 14. Further, it will be observed from the following report furnished by fibre merchants that these six samples were regarded from a commercial point of view as definitely inferior to the corresponding samples which had not been subjected to the 3 days' delay.

Commercial Value

The samples were submitted to a firm of merchants in London (Messrs. Wigglesworth and Co., Ltd.) who furnished the following report on their quality and value :

" *No.* 1.—3–3½ ft., medium greyish to brownish colour, similar to harsher descriptions of Madras Sunn, fibre not very well prepared, many coarse strips of fibre clinging closely together, heavy matted root ends, fair lustre, mostly strong but weak stricks here and there. Value £14 per ton.

" *No.* 2.—4 ft., similar to above but rather darker in colour, fair strength but fibres more gummed and adhering even than in No. 1. Not really satisfactory.

" *No.* 3.—3½–4 ft., similar fibre to No. 1 but lighter and softer, quite strong throughout but still contains a large

proportion of badly stripped adhering fibre, which makes it unsuitable for best marketing purposes.

"*No.* 4.—3½–4 ft., similar to No. 3 in practically all respects but slightly more gummed.

"*No.* 5.—3–3½ ft., much better than the previous four samples, fairly light colour with good gloss, soft fibre, fairly free and more like regular Bengal, mixed in strength, fair to very weak in parts, still contains some adhering fibre and some tick, soft root ends. Value £16 per ton.

"*No.* 6.—3½–4 ft., otherwise identical with No. 1 but a shade harsher.

"*No.* 7.—4 ft., similar to No. 6 but darker in colour, badly stripped, masses of adhering gummy fibre throughout.

"*No.* 8.—4 ft., similar to No. 3 but containing a fair amount of gummy adhering fibre; generally, however, fairly satisfactory as a marketable product. Value £15 to £16 per ton.

"*No.* 9.—3½–4 ft., rather darker than No. 8 and far less well prepared, containing large quantity of gummy adhering fibre and consequently lacking lustre, matted root ends.

"*No.* 10.—3½ ft., soft, light-coloured glossy fibre, very good appearance and about as free as ordinary Bengal, weak and fibre rather starty. Value £16 per ton. Might be worth more, except on the score of strength.

"*No.* 11.—Practically identical with Nos. 1 and 6, but harshest and most matted of the three.

"*No.* 12.—Like the other samples stripped after three days, it is harsh and unsuitable, containing too much gummy adhering fibre and darker colour, although strength superior to other samples.

"*No.* 13.—4 ft., a little softer than No. 3, fairly respectable fibre, although a certain amount of gummy adhering fibre, rather darker and less attractive in appearance than No. 8 although a little freer in fibre. Value £15 per ton.

"*No.* 14.—3½–4 ft., similar to Nos. 4 and 9, but like other samples stripped after three days not so suitable as those stripped wet; strong.

"*No.* 15.—3–3½ ft., similar to No. 10, medium strength in parts but mostly very weak, nice appearance.

"It is obvious from an examination of these 15 samples that material stripped on the third day after retting is not so satisfactory as that stripped wet, and that those retted for seven days, Nos. 5, 10 and 15, are undoubtedly most satisfactory, although the strength of Nos. 10 and 15 is rather seriously impaired in parts, which would leave us with No. 5 as being really the best sample.

"*No.* 16.—4 ft., medium, rather grey to brownish colour, not very well prepared, a good deal of gummy and adhering fibre, rather starty but on the whole better grown and weightier fibre than No. 1; might be a little more valuable on that account but actually there is very little difference.

"*No.* 17.—4 ft., lighter colour than No. 16, similar to Nos. 10 and 15, fibre fairly free, although still some gummy and adhering pieces, nice gloss, good strength throughout. Value £16 per ton.

"*No.* 18.—4 ft., well grown, medium colour but badly prepared gummy and adhering fibre throughout, spoiling the appearance and usability of the fibre.

"*No.* 19.—4 ft., similar to No. 17, not quite such light colour, otherwise preparation about the same, slightly less free, satisfactory in most respects.

"*No.* 20.—4–4½ ft., very well grown weighty fibre but identical with No. 18 as regards preparation, perhaps a shade softer.

"*No.* 21.—4–4½ ft., well grown fairly soft and free, still contains a certain amount of gummy fibre, almost identical with No. 19 but a shade softer.

"This group are all fairly good, with the exception of No. 18. No. 17 is probably the best and No. 16 the lowest from the point of view of marketable quality. In this group the difference between the seed rate is not very marked, but the three days' retting is less satisfactory than the five.

"*No.* 22.—5 ft., medium brownish to lighter colour, fairly well grown as shown by the length, but proportion very poor and containing a large quantity of gummy adhering fibre throughout, no freedom whatever in the

fibre, excellent strength. Possibly worth £15 per ton if the fibre was a bit freer.

"*No.* 23.—4½–5 ft., very similar in all respects to No. 22 and the only defect really is that the fibres are gummed together.

"*No.* 24.—5 ft., well grown, softer than No. 23, rather lighter colour but fibre is not really free enough; except for this quite satisfactory, excellent strength.

"*No.* 25.—5 ft., practically identical with No. 24, but harsher, bolder fibre, not sufficiently separated.

"Of this group No. 22 seems to be the best from the marketable point of view. Nos. 23, 24 and 25 have the appearance of being over-grown, the growth making the fibre too harsh and difficult to separate; otherwise for strength and length the ultimate fibre is really more satisfactory than some of the others. Five and seven days' retting of 157 days' growth would have been interesting to compare. It looks as though that might have yielded the ideal fibre of this type.

"*No.* 26.—3–3½ ft., dark grey to dark brown colour, nondescript appearance, quite easily the lowest in this respect of the whole lot, very dusty, but the fibre seems fairly soft, of good strength and not too badly matted. Might be worth £13 per ton."

The valuations quoted for these samples, viz. from £13 to £16 per ton, indicate that the better material is about equal in value to the grade of Indian Sunn hemp known as "Fine Philibit," which at the time was quoted at £14 10*s*. to £16 per ton (October 1932). The results of these experiments in the production of Sunn hemp in Uganda may therefore be regarded as quite promising, although there is considerable room for improvement if the material is to compare with the better qualities of the Indian product, the prices of which, at the same date, were as follows:

Fine Jubblepore	£16 10*s*.–£18 per ton.
Fine Sewnee	£17–£19 per ton.
Fine Itarsi	£18–£20 per ton.
Fine Dewghuddy	£20–£23 per ton.

GROUND-NUTS FROM SOUTH AND EAST AFRICA

(1) Southern Rhodesia

Nine samples of ground-nuts were forwarded to the Imperial Institute by the Chief, Division of Plant Industry, Southern Rhodesia, in July 1932.

The samples were stated to represent shelled and unshelled ground-nuts of types which could be made available in large quantities for export. It was desired that their quality and value should be ascertained, with special reference to the relative popularity of each type, the extent of the market for which each is suitable, the average price which it might normally be expected to realise, and the type of ground-nuts from foreign countries with which it would compete. Confirmation was also desired of certain details of the market requirements for ground-nuts required for various purposes (e.g. oil-crushing, the street barrow trade, the salted nut and confectionery trades) and the points raised in this connection are dealt with in the present report.

The samples were as follows:

No. 1. Spanish Bunch.—Ground-nuts in shell, in good, unbroken condition. The shells were covered with a film of reddish-brown earth. The size of the nuts varied from 1⅛ in. long by ½ in. in diameter to 2 in. long by ⅝ in. in diameter, being mostly 1½ in. long by ½ in. in diameter. The nuts contained mostly three kernels, but some had two, and others four. The kernels varied from small to large, being chiefly of medium size and were plump, with deep pink skins; in some cases the skins were pinkish-brown.

No. 2. Spanish Bunch. Washed in sand.—Ground-nuts in shell, in good unbroken condition, similar to those of sample No. 1, but almost entirely free from reddish-brown earth.

No. 3. Spanish Bunch (Kernels).—Small to medium-sized, plump kernels with skins of a deep pink colour but not of quite so deep a tint as the kernels of sample No. 1.

No. 4. Masumbika.—Ground-nuts in shell, in good unbroken condition. The shells were not of quite such good colour as those in sample No. 2. The nuts varied in size

from $1\frac{3}{8}$ in. long by $\frac{5}{8}$ in. in diameter to $2\frac{1}{4}$ in. long by $\frac{5}{8}$ in. in diameter, being mostly $1\frac{1}{2}$ to 2 in. long by $\frac{5}{8}$ in. in diameter. They contained either two or three kernels. The kernels were large, plump, with pale pinkish-brown skins, in many cases showing brown spots.

No. 5. *Masumbika Kernels.*—Large, plump, with pale pinkish-brown skins; similar to those of sample No. 4.

No. 6. *Virginia Bunch.*—Ground-nuts in shell, in good, unbroken condition. The shells were not of such good colour as those of sample No. 4. The nuts varied in size from $1\frac{3}{8}$ in. long by $\frac{5}{8}$ in. in diameter to 2 in. long by $\frac{3}{4}$ in. in diameter, being mostly $1\frac{1}{2}$ in. long by $\frac{5}{8}$ in. in diameter. The nuts nearly all contained only two kernels. The kernels were large and on the whole plump, with pinkish-brown skins.

No. 7. *Virginia Bunch* (*Kernels*).—Large, plump, pinkish-brown and similar to those of Sample No. 6.

No. 8. *Jumbo.*—Ground-nuts in shell, in good, unbroken condition. The shells were reddish-brown owing to the presence of earth. The nuts varied in size from $1\frac{1}{2}$ in. long by $\frac{5}{8}$ in. in diameter to $2\frac{1}{4}$ in. long by $\frac{3}{4}$ in. in diameter, being mostly $1\frac{5}{8}$ in. long by $\frac{5}{8}$ in. in diameter. Most of the nuts contained only two kernels. The kernels were large and plump, with pinkish-brown skins.

No. 9. *Jumbo* (*Kernels*).—Large, plump, with pinkish-brown skins and similar to those of Sample No. 8.

Samples No. 1 (Spanish Bunch), No. 4 (Masumbika), No. 6 (Virginia Bunch) and No. 8 (Jumbo) were examined in detail with the following results:

		No. 1. Spanish Bunch.	No. 4 Masumbika.	No. 6. Virginia Bunch.	No. 8. Jumbo.
Average weight of nuts	*grams*	1·8	3·2	2·5	2·9
Average weight of kernels	*grams*	0·45	0·86	0·90	1·02
Shell	*per cent.*	24·1	29·9	28·7	30·5
Kernels	*per cent.*	75·9	70·1	71·3	69·5
Oil in entire nuts	*per cent.*	34·2	30·6	31·4	30·6
Moisture in kernels	*per cent.*	5·4	5·7	5·7	5·8
Oil in kernels as received	*per cent.*	45·1	43·6	44·1	44·0
Oil in moisture-free kernels	*per cent.*	47·7	46·2	46·8	46·7
Acid value of extracted oil		0·3	0·3	0·7	0·9
Equivalent to free fatty acids (expressed as oleic acid)	*per cent.*	0·15	0·15	0·35	0·45

These results show that the four varieties, as represented by the samples examined, contain normal amounts of oil, and would be suitable for crushing, although the Masumbika, Virginia Bunch and Jumbo nuts have a rather high percentage of shell. The acidity of the extracted oils was in each case satisfactorily low.

Commercial Value

(A) The ground-nuts were submitted for valuation to a firm of merchants in London (Messrs. Fuerst Bros. and Co., Ltd.), who stated that they had recently been approached by the High Commissioner for Southern Rhodesia with reference to the Masumbika variety and had received from him samples of (*a*) large and (*b*) medium kernels. They further mentioned that they had received notification that a much larger supply of ground-nuts was expected this year from South Africa than was shipped last year, and expressed the view that the arrival of this increased quantity from the Union might cause the prices of South African ground-nuts to fall appreciably. The firm offered the following observations on the present samples :

"*No.* 1. *Spanish Bunch in Shell.*—The colour of the shells of these nuts is not suitable for the barrow trade, but the nuts would be saleable in certain circumstances, e.g. when supplies of other and better kinds were short.

"*No.* 2. *Spanish Bunch in Shell, washed in sand.*—This is the best of the four samples of ground-nuts in shell, and is currently worth 33*s.*–35*s.* per cwt. spot, ex wharf, as compared with Chinese new crop hand-picked selected nuts in shell at 13*s.*–14*s.* per cwt. c.i.f. This high value of the nuts is due both to their superior quality and to the limited supply at present available.

"*Nos.* 4, 6 *and* 8. *Masumbika, Virginia Bunch and Jumbo in Shell.*—In the present state of the market it is not advisable to ship these varieties in shell.

"*No.* 3. *Spanish Bunch Kernels.*—These kernels, whilst somewhat inferior to Spanish-grown kernels of this variety, are about equal to those exported from South Africa. The current value is 25*s.* per cwt. spot. It is essential that

the quality of such kernels should be maintained in all shipments.

"*Nos. 5, 7 and 9. Masumbika, Virginia Bunch and Jumbo Kernels.*—These kernels, like the samples of large and medium Masumbika kernels recently sent to the firm by the High Commissioner for Southern Rhodesia, would realise from 1*s.* to 2*s.* per cwt. more than Chinese hand-picked selected kernels, which are quoted at 17*s.* per cwt. c.i.f. (October–November) and are being offered by sellers at 14*s.* per cwt. for November–December. Of the five samples of kernels concerned, the large Masumbika kind would have a slight preference on the market."

The above remarks indicate the relative popularity of the different varieties, but Messrs. Fuerst stated that it is not possible to estimate the actual extent of the market for which each kind is suitable. "Normal" prices cannot be supplied, as there is no such thing as normality in this trade.

(B) The samples of ground-nuts in shell, Nos. 1, 4, 6 and 8, were also submitted to a second firm, Messrs. Volkart Bros. This firm forwarded the nuts to a trade expert, who made the following observations on the samples as received and on the kernels extracted from them :

"*(a) Ground-nuts in Shell*

"*No. 1. Spanish Bunch Red* are already known in this market. They are of the Valencia type, and the price here on the spot is about 31*s.* per cwt.

"*No. 4. Masumbika.* There is no interest for these.

"*No. 6. Virginia Bunch.*—These are equal to the Chinese in shell and have to compete against them. The value to-day is about 14*s.* 9*d.* per cwt.

"*No. 8. Jumbo.*—These are not wanted, and there is no future for them.

"*(b) Extracted Kernels*

"*No. 1. Spanish Bunch* is equal to Javas and has to compete against them. They are offered to-day at 16*s.* 6*d.* per cwt. for Nov./Dec. shipment and the market is declining.

"*No. 4. Masumbika.*—Very similar in appearance to the Chinese but not so good in flavour.

"*No.* 6. *Virginia.*—Equal to the selected Chinese, 38–40 nuts per oz., which can be purchased at 14*s.* 6*d.* per cwt. c.i.f. for Nov./Dec. shipment.

"*No.* 8. *Jumbo.*—Equal to the best Chinese, 30–32 nuts per oz.; value 15*s.* 6*d.* to 16*s.* per cwt. c.i.f.

"From the foregoing you will see that there is a market here for the regular kinds. Purchases are usually made in 10–25 ton lots."

The following information with reference to the points raised by the Chief, Division of Plant Industry, was furnished by Messrs. Fuerst Bros. and Co., Ltd.:

(*a*) Southern Rhodesian ground-nuts, both in shell and as kernels, have to compete in the United Kingdom chiefly with Chinese hand-picked selected nuts and to some extent also with the Indian and Spanish products; they have the benefit of the existing import tariff.

(*b*) A premium over Chinese and Java nuts is obtainable in the market for Rhodesian Spanish Bunch in shell, *washed in sand.*

(*c*) For oil-seed crushing, it is more usual to ship ground-nuts as kernels than in shell.

(*d*) For the barrow trade, bleaching is permissible provided the kernels are not damaged, and that the treatment given does not render the product liable to penalty under the Food Acts in force in England. Pale pink skins are not essential, though preferred by some buyers. The nuts are not usually graded, but in the case of nuts in shell the more kernels the pods contain the higher the market value. The firm had recently sold certain parcels of Rhodesian ground-nuts, the shells of which had been bleached, and in their opinion rather over-bleached.

(*e*) For the confectionery trade, kernels with pale pink skins are preferred, but are not essential. Chinese kernels are graded, but grading is not of great importance. The type represented by large Masumbika kernels is most popular as regards size. Chinese kernels are hand-picked selected; Javan are not.

(*f*) No special containers are necessary for either nuts or kernels; they are usually packed in bags, sometimes in double bags. The mode of stowage of the kernels is

important, and they must not be packed damp. Heating and consequent sweating must be avoided.

(*g*) The firm did not recommend that attention should be given exclusively to growing Spanish Bunch nuts in Southern Rhodesia, but advised that the other varieties should also be cultivated on a moderate scale, as there is a possibility that at a future date some buyers may show a preference for them.

(2) UNION OF SOUTH AFRICA

Six samples of ground-nuts were forwarded to the Imperial Institute by the Empire Cotton Growing Corporation in November 1931. The samples have been received from the Corporation's Cotton Breeding Station at Barberton, Transvaal, for analysis and valuation. It was also desired to learn whether the nuts could best be shipped to the United Kingdom in the decorticated or in the undecorticated state.

Three of the samples had been shelled, i.e. they consisted of kernels only, and the other three represented undecorticated nuts. They were as follows:

No. 1. *Shelled Nuts* (*Japanese Variety*).
No. 2. *Shelled Nuts* (*Barberton Strain*).
No. 3. *Shelled Nuts* (*Spanish* 9 *Strain*).

These three samples all consisted of plump kernels, mostly of medium size, which were of even colour and attractive appearance. The kernels of Sample No. 1 had pinkish-red skins, whilst the skins of Nos. 2 and 3 were pinkish-buff.

No. 1*a*. *Unshelled Nuts* (*Japanese Variety*).—Undecorticated nuts varying in size from ½ in. long by ⅜ in. in diameter to 1¼ in. long by ½ in. in diameter, and mostly measuring 1 in. by ½ in. The shells were unbroken but were somewhat earthy. A few of the nuts had been attacked by insects. Most of the nuts contained two kernels, but a few had only one. The kernels were similar to those in the shelled sample No. 1.

No. 2*a*. *Unshelled Nuts* (*Barberton Strain*).—Undecorticated nuts varying in size from ½ in. long by ⅜ in. in diameter

to 1⅛ in. long by ½ in. in diameter, and mostly measuring 1 in. by ½ in. The shells were unbroken but were somewhat earthy. A few nuts had been attacked by insects. Most of the nuts contained two kernels, but a few had only one. The kernels were slightly smaller than those in the shelled sample No. 2, but otherwise were similar.

No. 3a. Unshelled Nuts (Spanish 9 Strain).—Undecorticated nuts varying in size from ½ in. long by ⅜ in. in diameter to 1⅛ in. long by ½ in. in diameter, and mostly measuring 1 in. by ½ in. The shells were unbroken but were somewhat earthy. A few nuts had been attacked by insects. Most of the nuts contained two kernels, but a few had only one. The kernels were slightly smaller than those in the shelled sample No. 3, but otherwise were similar. About 4 per cent. of the kernels were shrivelled or defective.

The samples were examined with the results shown in the following table :

		Shelled Nuts			Unshelled Nuts.		
Composition of Nuts		No. 1	No. 2	No. 3	No. 1a.	No. 2a.	No. 3a.
Kernel	*per cent*	—	—	—	82·6	79·7	80·0
Shell	*per cent*	—	—	—	17·4	20·3	20·0
Oil	*per cent.*	—	—	—	41·1	38·6	38·5
Composition of Kernels							
Average weight of sound kernels	*grams*	0·47	0·48	0·47	0·49	0·44	0·43
Moisture . . .	*per cent*	5·6	5·7	5·6	5·5	5·4	5·4
Oil in kernels as received .	*per cent*	49·3	48·1	48·5	49·7	48·4	48·1
Oil in moisture-free kernels	*per cent*	52·2	51·0	51·4	52·6	51·2	50·8
Extracted Oil							
Acid value		0·3	0·2	0·6	0·3	0·1	1·1
Free fatty acids (expressed as oleic acid)	*per cent*	0·15	0·10	0·30	0·15	0·05	0·55

The oils, as extracted with light petroleum, were of normal appearance.

The results of examination show that the undecorticated nuts in all cases contained normal percentages of kernel. The kernels of all six samples gave satisfactory yields of oil, the Japanese being slightly richer in oil than the two other varieties. The acidity of the extracted oil was satisfactorily low in each case.

Commercial experts consulted by the Imperial Institute expressed the opinion that for oil-crushing purposes the ground-nuts would be readily saleable and that it would be preferable to export them in the decorticated condition.

The kernels would rank in the market with East African ground-nuts and would be worth about £13 per ton in London (January 1932), i.e. about the same price as Coromandel machine-dried kernels.

As regards other outlets, it was not considered that the undecorticated nuts would find a market either for direct use as food or for confectionery, as they are not so large as the Chinese nuts usually employed for these purposes and the shells are not of so light a colour.

The kernels, however, would be suitable for edible use, either for sale in packets or as an ingredient for cakes, sweetmeats, etc. For such purposes the "Barberton" and "Spanish 9" varieties, owing to their light-coloured skins, would be preferred to the Japanese kernels, as they more nearly resemble the Java kernels at present in demand. They would now be worth about 20*s*. 6*d*. per cwt. in London with Java kernels at 22*s*. per cwt. The Japanese variety, with pinkish-red skins, would not be worth quite as much. It was suggested that, if it were possible to guarantee regular shipments, trial consignments of about 10 tons of the kernels should be sent to London to test the market.

The oils obtained from all the six samples would be suitable for use as a salad oil, or for margarine- or soap-making. Such oil, however, is too valuable to be offered for soap-making, as the quality is good and there is a large demand for ground-nut oil for the other purposes mentioned.

The exportation of decorticated nuts (kernels) has the great advantage that when shipped in this form the nuts occupy considerably less cargo space in vessels than when shipped in the shell, and there is therefore a reduction in the cost of freight. Care must, however, be taken that the kernels are thoroughly dried before shipment, as otherwise they are liable to deterioration through heating, and such damage may be sufficient to render the oil fit only for soap-making and the cake for use as a fertiliser instead of as a feeding-stuff.

(3) Tanganyika

Two samples of ground-nuts were forwarded to the Imperial Institute by the Director of Agriculture in August 1931. They consisted of undecorticated ground-nuts of the Virginia Bunch variety grown in the Ufipa District,

one at an altitude of 6,000 ft. at Sumbawanga, and the other at 2,500 ft. at Karema.

A previous sample of ground-nut kernels from the Ufipa Plateau was found on examination at the Imperial Institute to contain a low percentage of oil, and it was desired that the present samples of Virginia Bunch kernels should be examined in order to ascertain whether they were similar to the earlier sample in this respect.

The samples were as follows:

No. 1. *From Sumbawanga Seed Farm.*—Undecorticated ground-nuts in good, clean, unbroken condition. The nuts were ½ in. in diameter and varied in length from 2 to ¾ in., mostly from 1¼ to 1½ in.

The pods usually contained either two or three kernels, a few having either one or four. The kernels were from medium to large, and plump. They were covered with a deep pinkish-red skin. About 2 per cent. of the kernels were defective (i.e. shrivelled, undeveloped or mouldy).

No. 2. *From Karema.*—Undecorticated ground-nuts in good, clean, unbroken condition, and of a similar range of size to those from Sumbawanga.

The pods mostly contained three kernels, but some had either two or four kernels. The kernels were from medium to large, and plump. They were covered with a deep pinkish-red skin. The sample was free from defective kernels.

The samples were examined with the following results, which are shown in comparison with those obtained for the sample of kernels from the Ufipa Plateau examined previously at the Imperial Institute.

		Virginia Bunch Present samples from Sumbawanga	Virginia Bunch Present samples from Karema	Previous sample from Ufipa Plateau.
Composition of Nuts				
Shell	*per cent*	23·9	24·2	—
Kernel	*per cent*	76·1	75·8	—
Average weight of sound kernels	*grams*	0·52	0·48	0·43
Composition of Kernels				
Moisture	*per cent*	7·3	7·6	6·3
Oil in kernels as received	*per cent*	45·3	43·9	40·9
Oil in moisture-free kernels	*per cent.*	48·9	47·5	43·7
Oil in entire nuts	*per cent.*	31·5	33·3	—
Extracted Oil				
Acid value		0·6	0·5	1·7
Equivalent to free fatty acids (expressed as oleic acid)	*per cent.*	0·3	0·25	0·85

The oils, as extracted from the kernels with light petroleum, were of normal appearance and their acidity was satisfactorily low.

The foregoing results show that the proportion of kernel to shell was satisfactory in each of the present samples. The average amount of oil expected by oil-seed crushers in consignments of East African decorticated ground-nuts is 47 per cent., although this figure is liable to fluctuation from one season to another by fully 2 per cent. On this basis the yield of oil from these Virginia Bunch kernels must be regarded as a little below the normal. It is of interest, however, that the sample from the higher altitude contained the higher percentage of oil.

The kernels of both the present samples contained higher percentages of oil than the previous sample of kernels from the Ufipa District submitted to the Imperial Institute.

In connection with this investigation it should be mentioned that the kernels of the Virginia Bunch variety are reported to yield a low percentage of oil in other countries. In the United States they are stated to give 5–10 per cent. less oil than the Spanish varieties (*Farmers' Bulletin No.* 751, 1916, *U.S. Department of Agriculture*); a comparison of twelve samples of Spanish Bunch and nineteen samples of Virginia Bunch ground-nuts showed that the average yield of oil from the Spanish kernels was 50 per cent. (or 52·5 per cent. calculated on the moisture-free kernels), whilst the Virginia kernels yielded only 41·7 per cent. (or 43·3 per cent. calculated on the moisture-free material). A similar result was obtained at the Salisbury Agricultural Experiment Station, Rhodesia, where the kernels of the Spanish Bunch type were found to yield 49·4 per cent. of oil, and those of the Virginia Bunch type only 43·3 per cent., although samples of these two varieties from Rhodesia examined at the Imperial Institute showed much less variation (see p. 151).

The results of the examination of the present samples therefore appear to be satisfactory for Virginia Bunch ground-nuts, and the rather low percentage of oil cannot be regarded as indicating that ground-nuts grown in the Ufipa District are liable to be deficient in oil owing to

climatic or other local conditions. It would, however, be of interest to examine a further sample of the Virginia Bunch nuts from Ufipa together with samples of the same variety grown in other localities in Tanganyika during the same season, in order to see the extent of the variation between them.

It might also be worth while to carry out a trial at Ufipa with a variety known to give a high yield of oil when grown elsewhere in the Territory, with a view to determining whether any diminution in the oil-content occurs. A control sample from another locality would also be desirable in this case.

ARTICLES

THE COLLECTION OF REPTILE SKINS FOR COMMERCIAL PURPOSES WITH REFERENCE TO THE POSSIBILITIES IN EMPIRE COUNTRIES

The attention of the Imperial Institute Advisory Committee on Hides and Skins was recently drawn by one of its members to the increasing demand for reptile skins for the production of leather and to the very large dimensions which the trade in the raw skins has already assumed. India is one of the largest sources of supply, and other Empire countries are exporting considerable quantities of the skins. It was suggested that the desirability of encouraging the production of reptile skins on sound lines in British countries overseas should be investigated, and the Committee decided to appoint a Sub-Committee for this purpose.

It was realised that due regard must be given to the possible effects of the intensive exploitation of reptiles for their skins, and it was accordingly agreed to include a zoologist on the Sub-Committee in order that this aspect of the question might receive full consideration. The authorities of the British Museum (Natural History) were approached in this connection and kindly nominated Mr. H. W. Parker, B.A., Assistant Keeper in the Department of

Zoology, whose wide knowledge of the subject was of the utmost value.

The Sub-Committee was finally constituted as follows :

Dr. Dorothy Jordan Lloyd (Director, British Leather Manufacturers' Research Association), *Chairman.*

A. F. R. Cotton (Messrs. Culverwell, Brooks & Co.).

H. W. Parker, B.A. (Assistant Keeper, British Museum, Natural History).

Sir David Prain, C.M.G., C.I.E., F.R.S. (Chairman, Advisory Council on Plant and Animal Products, Imperial Institute).

Dr. J. R. Furlong (Imperial Institute), *Secretary.*

The report of the Sub-Committee was unanimously approved by the main Committee and is printed in the following pages. Subject to the adoption of Government regulations to control the collection of skins and the enforcement of general protective measures on the lines indicated in the report, it is concluded that the collection of reptile skins from new sources and the extension of the trade in those countries which are already producing can be recommended.

The report includes a list of the species, the skins of which are already in commerce, and also a list of other species, the skins of which may be worth collection. In both lists the Empire countries where the species occur are indicated. Information regarding the best methods of preparing the skins for the market is given in Appendix III.

The Imperial Institute will be glad to deal with any enquiries on the subject of reptile skins and to receive samples of skins for identification and commercial valuation.

REPORT OF THE SUB-COMMITTEE

This report deals with the skins of lizards, snakes, crocodiles and alligators for the manufacture of leather. The skin of the crocodile has been in regular use for a considerable period, but the industry in snake and lizard skins on a large scale is comparatively recent. Lizard skins of Javan and South American origin were in commerce twenty-five years ago, but a regular trade only developed

in 1926, supplies coming principally from Java and the neighbouring islands and British India. Subsequently Mexico and Brazil were included as sources of supply. In 1926 reptile skins were employed only for luxury articles, the chief use being for upper leather for high-priced shoes. The use of reptile skins in the leather industry has increased rapidly since 1926, and to-day the skins are used for the mass-production types of shoes, as well as for bag and fancy leathers.

The use of reptile skins was at one time considered to be subject to fashion, but the view is now strongly held by the leather trade and by technical experts in the industry that the skins are established as a raw material for leather production on as permanent a basis as goat, calf and sheep skins. Some of the advantages attaching to reptile skins are as follows: (1) Hard wearing qualities; they yield stronger leather than sheep, goat or even calf skins. (2) They offer a very large variety of pattern and design. (3) Reptile skins can be finished in any colour, whereas only the best grades of goat skins are suitable for colour work. It may also be observed that the variety of finish and colour of which reptile skins are capable provides wide scope for changes of fashion.

Statistics relating to collection and export of reptile skins in the various producing countries are incomplete, but the following figures convey an idea of the extent of the trade. It is estimated that in the year 1932 India exported about 2,500,000 reptile skins, in the month of September over 600,000 reptile skins, chiefly lizard skins, were shipped from Calcutta alone. In 1931 over 2,000,000 reptile skins were exported from the Dutch East Indies, of which 80 per cent. were snake skins, while the remainder were lizard skins.

The collection of reptile skins has been organised on a commercial basis in India, Ceylon, Dutch East Indies, Siam, Brazil and the Philippine Islands. Skins from these countries are not only sold on consignment, when the skins are usually sorted in London, but selection and grading have been established in the country of origin, thus permitting shipment on a fixed specification of description, size and quality. The assortments, made at origin, of

lizard skins in India, Java, Indo-China and Brazil, for instance, are well known, and values can be quoted with the same exactitude as for cattle hides, and more definitely than for goat and sheep skins.

Lizard and snake skins are also collected in West Africa, East Africa, and Rhodesia, the shipments of monitor-lizard and python skins from Nigeria being on a large scale.

The output from the Empire could be increased, firstly, by organising collection on sound lines in countries where commercial collection is now in being, and, secondly, by establishing the industry in areas which hitherto have not participated in the trade.

For both classes of countries it is of paramount importance that the authorities and the trade should consider carefully the possible ill effects of intensive exploitation of reptiles for their skins.

The effects which may be expected to result from the slaughter of great numbers of the larger reptiles in any area are of two kinds :

(a) *Indirect.*—The majority of reptiles are carnivorous and predatory. The ratio of predators to prey in a district is presumably fairly constant under stable conditions, and any appreciable diminution of the numbers of the one may be expected to lead to a change in the numbers of the other. Rodents form a large proportion of the staple diet of the larger snakes, and any increase in the number of rodents, which might result from the removal of this check on their numbers, is likely to prove injurious to man.

(b) *Direct.*—Wherever a species of reptile has been persistently hunted by man for commercial purposes, its numbers have almost always been reduced, or it has been completely exterminated. Examples are given in Appendix I.

There is considerable evidence to show that uncontrolled, indiscriminate slaughter of reptiles for their skins is likely to produce a serious diminution of their numbers. Such a result is eminently undesirable, not only from a zoological standpoint but as jeopardising the future of the industry itself. Consideration must therefore be given to the conservation of resources by affording protection,

officially enforced, and to the possibilities of breeding reptiles on a commercial scale. On these two points the following observations may be made.

(1) *Protection.*—This has been found an effective remedy in other instances where over-hunting or over-fishing has endangered a species, and there is no apparent reason why it should not be equally effective for reptiles. The difficulty is to determine what measure of protection is necessary in each case and when it can most advantageously be applied ; obviously no general measure can be equitable.

On *a priori* grounds it seems probable that species with a limited geographical distribution, even though they are plentiful within their restricted area, will be most easily endangered. Direct evidence that this supposition is well founded is provided by the fate of the Giant Tortoises and the Tuatara, which, restricted to certain small islands, have been almost exterminated by man, and by the depletion of the reptile fauna of the West Indies since the introduction of the mongoose. Common widely distributed species, on the other hand, are much less likely to suffer seriously ; but to safeguard the future of the industry, protection during the breeding season, when the skins are reported to be thinnest and of least commercial value, might be imposed. It is highly probable that the breeding season of a widely distributed species differs in different regions, and, certainly, it is often greatly protracted ; extreme observations may sometimes indicate an apparent breeding season of nine months or more, but in most instances it will be found that there is a relatively restricted peak period the incidence and duration of which can only be determined by local observations.

Hornell recommends in the case of the Hawksbill Turtle (a widespread form not in any immediate danger of extermination) that a close season of one year should automatically follow any fall of production below a certain minimum based on the average production of preceding years ; this close season would be followed by two open ones, but if production had still not reached the minimum at the end of that period, a further year's close season would automatically follow. This recommendation appar-

ently presumes a constant demand and would need modification where fluctuations of demand rather than of supply might influence production. It may be mentioned that the cessation of supplies of any particular reptile skin for a lengthy period would be a handicap to trade, since for manufacturing purposes a regular periodic supply is more desirable than one which is subject to irregular interruptions.

Another type of protective measure which has been successful in aiding the re-establishment of persecuted species is the formation of reserves. Whether reserves would assist in maintaining the numbers of reptiles in the surrounding country seems doubtful, except in the case of definitely migratory species which can be protected in their breeding range. Migrations of this nature have not been shown to occur in any terrestrial reptiles, but some sea-snakes, at least, are known to resort to the shore for breeding purposes (*Laticauda*). The only experimental reserve for reptiles definitely known to exist is Chidampiri Island, Lake Shirwa (Chilwal), Nyasaland, which was established for the protection of pythons in 1930. Reports on the conduct and progress of this experiment are most desirable.

(2) *Reptile Farms.*—Attempts have been made from time to time to propagate captive reptiles for commercial purposes. These efforts have, as a rule, been the result of private enterprise and have been undertaken with little or no knowledge of the biology of the animals concerned, so that it is not surprising to find that there has been a greater measure of failure than of success. No farms have been commercially successful in rearing marine turtles for the market, and the various alligator farms in the United States are reported to derive not more than a twentieth part of their revenue from the sale of skins taken from animals reared in captivity. The " Snake Parks " of South Africa (Port Elizabeth) and Brazil (Butantan) are sometimes reported as commercially successful ventures, but in neither is any serious effort at propagation on a large scale undertaken; the snakes are, for the most part, wild specimens retained in captivity for the sake of their venom.

Nevertheless, farming offers reasonable prospects of success if properly carried out with suitable species.

Hornell is of the opinion, after a practical examination of the subject of turtle farming, that the Hawksbill Turtle could be reared in confinement with success, provided that the undertaking was carried out intelligently and on a large scale. The United States Bureau of Fisheries has carried on an experimental Terrapin farm for a number of years and has accumulated sufficient experience to make the rearing of these reptiles commercially worth while (for details and bibliography see Hildebrand, *Bull. U.S. Bureau Fish.*, 1929, xlv, p. 25). But it must be emphasised that a great deal of preliminary work will be necessary before the farming of snakes or lizards can be attempted with any prospect of success. First of all it is necessary to discover, experimentally, which of the leather-producing species in a country are amenable to confinement; many cannot be induced to feed readily in confinement, and even greater difficulty is to be expected in inducing them to breed. A thorough knowledge of the animals' natural haunts, food, diseases, enemies and reproductive habits is essential, but at present information on these points is almost non-existent for the majority of species. Finally, information on the space requirements of young and adults, sex ratios, and growth rates is very necessary and can only be obtained by direct experiment.

Unless the growth rate can be accelerated by selective breeding, or by special diet, or by both, no reptile is likely to be remunerative in less than three to four years.

Summary and Recommendations

1. Authoritative opinion indicates that reptile skins are permanently established as a raw material for the tanning trade; a large market exists for the skins, and the demand will probably increase.

2. The commercial exploitation of reptiles for their skins will no doubt increase, whether or not official encouragement be given to collection.

3. It is of great importance that the possible ill effects of the extermination of one or more species in a district by intensive or uncontrolled exploitation should be appreciated by all concerned.

4. Local conditions should be carefully considered, and Governments are recommended to consider regulations to control the collection of skins, and the enforcement of general protective measures, on the lines indicated in this report. It is further recommended that minimum size limits be imposed. It is suggested that the killing of lizards of less maximum girth than seven inches should be prohibited, and that the minimum width of skins for Boas and Pythons should be eight inches. In other snakes the minimum width of the skin collected should vary according to the maximum size of the species, but should never be less than four inches.

5. Provided that safeguards against undesirable effects are secured, the collection of reptile skins from new sources in the Empire, and the further development of the industry in countries where it already exists, is recommended. Lists of reptiles to which attention is directed are given in Appendix II. Methods for the preparation of reptile skins for the market are given in Appendix III.

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H. W. Parker.
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April, 1933.

APPENDIX I

Examples of the Effects of Hunting Reptiles for Commercial Purposes

The only reptiles concerning which reliable information is available are those which have been subject to hunting over a long period, viz. alligators, turtles and tortoises; lizards and snakes have only recently been killed in large numbers, and the effects of the intensive hunting of these reptiles are not yet fully known.

1. The North American Alligator has been hunted for its skin intermittently since about 1800. The annual catch has greatly fallen off despite the increasing demand,

The total number of skins produced in the United States in 1902 was estimated at about 140,000; in recent years production cannot have exceeded 50,000 skins annually.

2. The edible Terrapins of the eastern United States. Hildebrand (*Bull. U.S. Bureau Fish.*, 1929, xlv, p. 26) states: "It was quite evident by the beginning of the present century that these valuable creatures were being reduced so rapidly that very soon they would be so scarce as to make fishing for them unremunerative, if, indeed, the animals were not doomed to extinction."

3. The Green Turtle. This reptile is everywhere being rapidly reduced in numbers. The average annual value of the dried meat exported from Jamaica in the three-year period 1001–1903 was approximately £6,550, whereas in the period 1929–1931 the value of the same product was less than £2,000; in these two periods the average number of live turtles exported annually fell from more than 2,600 to less than 50. Prices and demand do not appear to have fluctuated greatly.

In regard to the Seychelles region Hornell ("The Turtle Fisheries of the Seychelles Islands," 1927, H.M. Stationery Office) states: "The Green Turtle is decreasing rapidly in numbers. Already it has become so scarce in the northern islands as to be of negligible value there; in the Amirantes its numbers do not constitute a fishery; alone in the Aldabras are there still considerable numbers, but these are nothing to what they were at the beginning of this century or even fifteen years ago."

4. The Giant Tortoises of the Galapagos Islands and the islands of the Indian Ocean. These were ruthlessly hunted for their flesh in the eighteenth century and have been almost completely exterminated.

On the other hand it appears that the Hawksbill Turtle, which has been hunted since time immemorial for its tortoiseshell, shows no serious diminution in numbers. The Jamaican exports show a steady increase from 1900 to 1931, while the exports from the Seychelles during this period have been well maintained.

APPENDIX II

Lists of Reptiles

(A) List of the principal species, the skins of which are already in commerce: (1) Lizards, (2) Snakes, (3) Crocodiles and Alligators; showing trade name, scientific name, origin of present supplies, commercial value of skins, together with notes on the habits and special features of each variety.

The list also shows the Empire countries where these reptiles are found. Some of these countries are already sources of commercial supplies; the others are possible new sources.

(B) List of species found in Empire countries, the skins of which are not at present commercially collected, but are worthy of consideration for that purpose: (1) Lizards, (2) Snakes.

List A was prepared from commercial skins, while B was compiled after a systematic inspection of specimens at the Natural History Museum, London, from the point of view of suitability for trade purposes.

It will be noticed that frequently in List A the same species from different regions receives different trade names and the skins have different values. This may be due to differences in the method of preparation and preservation or to the existence of local colour varieties which have not been deemed of sufficient zoological importance to warrant their receiving distinctive names. The probability of similar conditions occurring in the species of List B must be borne in mind. Local and vernacular names have been added where possible, but these names are often current only in very restricted areas and are very loosely applied; accurate identification is essentially a matter for the specialist. Details of the breeding season have sometimes been added, but no systematic search for breeding records has been undertaken. It is of little value to know when eggs may be laid or young born, if the period of gestation is unknown, and isolated records, which is all that can usually be obtained, can be very misleading owing to those geographical fluctuations and prolongations of the breeding season which have been mentioned in the report.

Certain species are noted which are known to be rare and to have a very restricted distribution; they cannot, therefore, be of very great commercial importance (unless they can be successfully farmed), and unrestricted hunting will certainly endanger the existence of the species. It is recommended that complete protection be afforded them at once.

The values of reptile skins already on the market are shown in List A, the prices being spot, London, January 1933. These prices are subject to fluctuation and are given only as an indication of comparative values.

The lists are given on pp. 174–196.

APPENDIX III

Methods of Preparation of Reptile Skins for the Market

Lizard Skins

The skins must be cut open down the belly, with the tails cut down the back, the heads and legs being opened out so as to obtain maximum spread of skin. The only exceptions to this are Iguanas and Chamæleons, where there is a fringe down the centre of the back. These species must be cut open down the back.

After the skin has been removed it should be carefully washed, great care being taken to remove all flesh from the skin, also from the head, tail, etc.

Skins should preferably be shipped in dry condition, and should be carefully stretched and staked out to their full natural width, great care being taken not to overstretch the skin, which must then be dried in the shade. Dry skins can be packed in cases and bales, and the use of naphthalene is recommended as a precaution against insect damage.

Before drying, it is preferable, if means are available, to put the skins through an arsenic wash, to minimise the possibility of insect damage.

Alternatively to being shipped in dry condition they may be shipped in wet-salted state, when a plentiful use must be made of finely crushed salt. In preparing the

salted skins it would be preferable in the first place to sprinkle the skins with coarse salt and stack them and allow them to drain thoroughly for twelve hours; they should then be packed in barrels, flesh to grain, with a plentiful application of finely crushed salt on each skin.

Lizard skins are required eight inches and over in width, ten inches and over being preferred.

The value is dependent upon:

1. *Marking.*—Lizard skins with distinctive marking are worth more than skins with little or no marking, and range in value from about 2*s.* up to say 8*s.* per skin in the raw state. Skins with little or no marking range from 8*d.* up to 2*s.* to 3*s.*

2. *Grain.*—The grain, whether prominent or flat, fine or large, considered in conjunction with markings. No general rule can be stated.

Snake Skins

These should invariably be cut open down the belly, and prepared in the same way as lizards. They should be carefully staked out to their full width without undue stretching, and shipped in dried condition. Pythons and large snakes should be rolled up singly. The smaller and shorter species of snakes should be shipped flat in bales or cases.

Larger snakes such as Pythons, Boas and Anacondas, are required in widths of skin from 8 to 12 inches. Values range from about 1*s.* 9*d.* up to 25*s.* per skin, according to district and marking.

Snakes other than the above are required in widths of four inches and over. The value is dependent upon:

1. Marking.
2. Scales, viz., whether they are flat or even, the size of scale, and whether or not they are overlapping, and will turn up instead of remaining flat in the finished leather. Smaller-scaled snakes are preferred.
3. Substance.

Small snakes vary in value from a few pence per skin up to say 10*s.*

Crocodile and Alligator Skins

Only the belly part of the skin is usable for leather. The hard bony scutes on the back are of no value. The belly part of the skin, including head, whole of the tail and legs, must, however, be taken off at the fullest possible width, leaving about two rows of scutes on each side of the skin. In taking off skins, cut as near to the middle of the back as possible over the legs so as to allow maximum width of skins at the legs; i.e. the skins when properly taken off should be as wide at the legs as in the centre of the body. The leg portions should also be left as long as possible, and cut exactly in the middle of the large scales on the top of the leg. In taking off skins great care must be taken to avoid butcher cuts and spear-holes, as a skin damaged in this way is classed as a "Second," and valued approximately at 15–20 per cent. less. All flesh must be carefully removed, and the skins properly washed, drained and thoroughly salted.

They should be shipped in bags, bales or barrels, preferably the latter. The belly part of the skin must never be folded down the middle. Skins should have the soft part of the sides and legs folded in, keeping the main portion of the skin (viz. the belly) flat. When shipping in bags or barrels, the skins after folding must be rolled with the scales outwards, and tightly packed. Only heavy bags should be used, which must be well roped. If put in bales, the soft part of the sides must be folded in with the flesh outwards, and packed so that the body part will lie flat. The bales should be covered with bagging, so as to prevent damage to the skins. When shipping in bales skins must never be folded with the scale side outwards, as this side would be exposed to possible damage during transit.

Skins are sold per skin, either by the length from tip to tail, or belly width in inches measured between the hard bony scutes. Skins are declassified as Seconds owing to damage, holes or cuts, badly cut open, viz. not full width and proper shape, insufficient salting, or for loose scales, i.e. top skin peeling off.

Lists of Reptiles

A. Principal species, the skins of which are already in commerce.

1. *Lizards.*

Africa, p. 174.
America, p. 175.
Asia (including Malay Archipelago and New Guinea), pp. 176–177.

2. *Snakes.*

Africa, p. 178.
America, pp. 179–180.
Asia (including Malay Archipelago, New Guinea and Melanesia), pp. 180–182.
Australia, p. 183.

3. *Crocodiles and Alligators.*

Sources of present supplies of skins, and Empire countries in which found, pp. 184–185.

B. Species found in Empire countries, the skins of which are not at present commercially collected but are worthy of consideration for that purpose.

1. *Lizards.*

Africa, p. 186.
America, p. 186.
Asia (including Malay Archipelago and New Guinea), p. 187.
Australia, p. 187.

2. *Snakes.*

Africa, pp. 188–189.
America, pp. 189–190.
Asia (including Malay Archipelago, New Guinea, and Melanesia).
Section 1—Land and fresh-water snakes, pp. 191–192.
Section 2—Sea-snakes, pp. 193–194.
Australia, pp. 195–196.

REPTILE SKINS

A. PRINCIPAL SPECIES, THE SKINS OF WHICH ARE ALREADY IN COMMERCE

A. 1. **LIZARDS** (All harmless)

Africa

Trade name	Scientific name	Origin of present supplies.	Empire Countries in which found [1]	Current value. Price per skin for width stated	Eggs or Young	Local names.	Remarks.
West African Small Grain	*Varanus niloticus*	Nigeria	Gambia, Sierra Leone, Gold Coast, Ashanti, Nigeria, British Cameroons	8 in or over 1/6	E	Nhengi, Kengi, Mbulu, Libulu	Known to Europeans as Monitors, Iguanas, Goannas and Leguaans
East African Small Grain	do	*ex* Mombasa	British Somaliland Anglo-Egyptian Sudan, Uganda, Kenya, Tanganyika Territory	9 in or over 2 6 to 3/6	E		
Rhodesian Small Grain	do	Rhodesia	Nyasaland, Rhodesia, Bechuanaland, South-West Africa, Union of South Africa	do	E		
West African Large Grain	*Varanus exanthematicus exanthematicus*	West Africa	Gambia, Sierra Leone, Gold Coast, Ashanti, Nigeria	8 in or over 1/-	E	—	
East African Large Grain	*Varanus exanthematicus ocellatus*	*ex* Mombasa	Anglo-Egyptian Sudan, British Somaliland, Uganda, Kenya, Tanganyika Territory	8 in or over 1/6	E	—	

[1] *Including the Anglo-Egyptian Sudan.*

A. 1. LIZARDS (All harmless)—(*contd.*)

AMERICA

Trade name	Scientific name	Origin of present supplies	Empire Countries in which found	Current value Price per skin for width stated	Eggs or Young	Local names	Remarks
Brazilian Teju	*Tupinambis teguexin*	Brazil	British Guiana	8 in up 2/-	E	Lagarto	Not common in British Guiana
Argentine Teju	do	Argentina	do	8 in 1 3 to 1 6	E	Tedyú-guasú	do
Jacarura	*Tupinambis nigropunctatus*	Brazil	British Guiana, Trinidad, Tobago	8 in 1/3	E	Yellow-banded Tegu	Widespread; common
Argentine Teju	*Tupinambis rufescens*	Argentina	—	8 in 1 9	E	—	—
Croco-Teju	*Dracæna guianensis*	Brazil	British Guiana (?)[1]	8 in 6/–	E	—	—
Cuban Lizard	*Cyclura macleayi*	Cuba	—	8–10 in 11*d* 10 in up 1,2–1/4	E	—	*Rare*
South American Chamæleon (sic)	*Iguana iguana*	Brazil	British Guiana, Trinidad, Tobago	8–10 in 9*d* 10 in up 1 2	E	Common Iguana	Widespread, common, valuable as food.

[1] *Not recorded from British Guiana, but almost certainly occurs there*

A. 1. LIZARDS (All harmless)—(*contd.*)

ASIA (INCLUDING MALAY ARCHIPELAGO AND NEW GUINEA)

Trade name.	Scientific name.	Origin of present supplies.	Empire Countries in which found.	Current value. Price per skin for width stated.	Eggs or Young.	Local names	Remarks.
Borneo Lizard	*Varanus salvator*	Borneo	North-East India, Burma, Ceylon, Federated Malay States, British North Borneo, Sarawak	9 in. up 4/- +	E	—	Common, wide-spread, frequenting rivers, canals and sea shore. Very variable in colour pattern from place to place and hence differing in value
Java Lizard	do.	Java	do.	10 in up 6/6 +	E	—	
Sumatra Lizard	do.	Sumatra	do.	10 in up 6/-	E	—	
Semi-Java Lizard	do.	Java	do.	10 in. up 3/-	E	—	
Singapore Lizard	do.	Federated Malay States	do.	10 in. up 4/6	E	—	
Siam Lizard	do.	Siam	do.	10 in. up 6/-	E	—	
Ramgodie	do.	India	do.	10 in. up 6/6 +	E	—	
Cabragoya	do.	Ceylon	do	10 in up 7/-	E	Kabara Goya	
Philippine Lizard	do.	Philippines	do.	10 in up 3/-	E	—	
Ambon Lizard	*Varanus indicus*	Amboina	British and North-East New Guinea, Bismarck Archipelago, Solomon Islands	8 in. up 9*d* – 1/-	E	—	Widespread through Malay Archipelago
Flower Lizard	do.	New Guinea	do.	8 in up 1/3	E	—	
Rice Lizard	*Varanus nebulosus*	Dutch East Indies	Southern Burma, Federated Malay States	8 in up 1/6	E	—	—
Penang Lizard	do.	Federated Malay States	do.	do.	E	—	—
Fish Lizard	*Varanus dumerili*	Dutch East Indies	Federated Malay States, British North Borneo, Sarawak	8 in. up 1/-	E	—	—

***Note.**—All the above are known to Europeans as Monitors, Goannas or Iguanas; to Malays as Biawak; in Northern India as Gho-samp or (juveniles) Biscobra.*

A. I. LIZARDS (All harmless)—(*contd.*)

ASIA (INCLUDING MALAY ARCHIPELAGO AND NEW GUINEA)

Trade name.	Scientific name.	Origin of present supplies.	Empire Countries in which found.	Current value. Price per skin for width stated.	Eggs or Young.	Local names.	Remarks.
[1] Tree Lizard .	*Varanus rudicollis*	Dutch East Indies, Philippines	British North Borneo, Sarawak	9 in. up 1/6–2/–	E	—	More arboreal than most species of *Varanus*
[1] Baghdad Small Grain	*Varanus griseus*	Persia (via Baghdad)	North-West India, Aden	8 in. up 6*d*. nom.	E	Waral, Ouaran	Desert and Steppe species
[1] Indian Small Grain .	*Varanus monitor*	United Provinces (?)	India, Burma, Ceylon	8 in. up av. 10 in. 1/–	E	—	Breeding season Mar.–Apr. Eggs and adults eaten as delicacies
[1] Bengal Lizard	do.	Bengal	do.	8 in. up av 10 in. 1/10	E	—	
[1] Talagoya .	do.	Ceylon	do.	8 in up av 10 in 1/8	E	Talagoya	
[1] Indian Oval Grain	*Varanus flavescens*	India	Northern India (Bengal, United Provinces, Bihar and Orissa, Punjab)	8 in up 1/6 +	E	—	*Rare and restricted in range. Perhaps requires protection*
[1] Philippine Lizard	*Varanus cumingi*	Philippines	—	8 in up 2/–-3/6	E	—	Restricted, Philippines
[1] Philippine Lizard	*Varanus nuchalis*	do.	—	8 in up 2/–-3/6	E	—	
Pararang .	*Hydrosaurus microlophus*	Celebes	—	8 in up 2/6–3/–	E	—	Trees near water. *Range restricted*
Pohon .	*Hydrosaurus amboinensis*	Amboina, Ceram	—	8 in. up 2/6–3/–	E	—	
Crested Lizard	*Hydrosaurus Weberi*	Halmaheira	—	8 in. up 2/6–3/–	E	—	
Crested Lizard	*Hydrosaurus postulosus*	Philippines	—	8 in. up 2/6–3/–	E	—	
Horn Lizard .	*Uromastix asmussi*	Persia (via Baghdad)	Baluchistan	8 in. up 3/9 7 in. 2/3 6 in. 1/–	E (?)	—	*Probably in danger of depletion. Very restricted range*
Horn Lizard Small Grain	*Uromastix microlepis*	Persia, Iraq	Aden (?)	nom. 1/–	E	Dab	*Steppe–Desert species. Restricted range*

[1] *Known to Europeans as Monitors, Goannas or Iguanas ; to Malays as Biawak ; in Northern India as Gho-samp or (juveniles) Biscobra.*

A. 2. SNAKES

Africa

Trade name.	Scientific name.	Origin of present supplies.	Empire Countries in which found.	Current value. Price per skin or unit length for width stated	Eggs or Young	Venomous or Harmless.	Local names.	Remarks.
West African Python	*Python sebæ*	Nigeria	Gambia, Sierra Leone, Gold Coast, Ashanti, Nigeria, British Cameroons, Anglo-Egyptian Sudan, British Somaliland, Tanganyika Territory, Uganda, Kenya, Nyasaland, Bechuanaland, Rhodesia, Union of South Africa	8 in. up 5/6 metre length (about 13/- skin)	E	H	—	Pairing Mar.–Apr. Eggs laid Oct.–Jan.; peak of laying period Dec.–Jan. (South Africa)
Royal Python	*Python regius*	West Africa	Gambia, Sierra Leone, Gold Coast, Ashanti, Nigeria	1/9 skin	E	H	—	—
Black Mamba (sic)	*Naja nigricollis*	West Africa	As for West African Python	1/- skin nom.	E	Ven. (dangerous)	Black-necked cobra	—
Rhinoceros Viper (sic)	*Bitis arietans*	West Africa	do.	6*d.* skin	Y	do.	Puff-adder	Rhinoceros viper is a different animal. (*See* B. 2, Africa.)

A. 2. SNAKES—(*contd.*)

America

Trade name.	Scientific name	Origin of present supplies	Empire Countries in which found	Current value Price per skin or unit length for width stated	Eggs or Young	Venomous or Harmless	Local names	Remarks.
Giboyas	*Constrictor constrictor*	Brazil	British Guiana, Trinidad, Tobago	8–14 in wide 2/6 metre length	Y	H	Boa constrictor, Macajuel	Pairing Dec.–Mar. Gestation six months (Trinidad)
Masacnate	*Constrictor imperator*	Mexico	British Honduras	do	Y	H	—	—
Ampalagua	*Constrictor occidentalis*	Argentina	—	3/6 skin	Y	H	—	Confined to Argentina
Araramboia	*Epicrates cenchris*	Brazil	British Guiana, Trinidad, Tobago	1/- to 1/6 per skin	Y	H	Mapepire-velour, Jack	Pairing Oct.–Jan. Gestation nine months (Trinidad)
Maja	*Epicrates angulifer*	Cuba	—	4–6 in wide 3/- 7 in up 10/- per skin	Y	H	—	Confined to Cuba
Anaconda	*Eunectes murinus*	Brazil	British Guiana, Trinidad	8–14 in wide 2/10 metre length	Y	H	Huile, Anaconda	Pairing Dec.–Jan. Young born July–Aug. (Trinidad)
Anaconda	*Eunectes notaeus*	Argentina	—	do	Y	H	Lampalagua	—
Water Snake	*Natrix rhombifera*	Mexico	—	1/6 skin	E	H	—	—
Beach Cobra (sic), Cobra de Campo, Surucucu	*Cyclagras gigas*	Brazil		1/- skin nom	—	H	—	—
Cascavel	*Phrynonax sulphureus*	Brazil	British Guiana, Trinidad	1/- skin nom	E (?)	H	—	*Rare in Trinidad*

A. 2. SNAKES—(contd.)

AMERICA (contd.)

Trade name.	Scientific name.	Origin of present supplies.	Empire Countries in which found.	Current value. Price per skin or unit length for width stated	Eggs or Young.	Venomous or Harmless.	Local names.	Remarks.
"Kali"	*Spilotes pullatus pullatus*	Brazil	British Guiana, Trinidad, Tobago	3*d*. skin nom.	E (?)	H	Tigre	—
Palmera	*Spilotes pullatus mexicanus*	Mexico	British Honduras	6*d*. skin nom.	E (?)	H	—	—
Black Snake	*Coluber constrictor*	Mexico	—	do.	E	H	—	—
Cuban Mamba (sic)	*Alsophis angulifer*	Cuba	—	do.	E	H	—	—
Sucurua Deer Snake	*Lachesis muta*	Brazil	British Guiana, Trinidad	1/– skin nom.	E	Ven. (dangerous)	Bush-master, Mapepira, Z'Ananna, Surucucu	—
Rattlesnake	*Crotalus terrificus*	Brazil	British Honduras, British Guiana	6*d*. skin nom	Y	do.	Rattle-snake, Cascavel	—
ASIA (INCLUDING MALAY ARCHIPELAGO, NEW GUINEA AND MELANESIA)								
Indian Python	*Python molurus molurus*	India	South India, Ceylon	8–12 in 1/6 per foot length	E	H	—	Commonest and most widespread of Oriental Pythons. Pairing Dec.–Feb.; Eggs laid Mar.–June in India.
Bengal Python	*Python molurus bivittatus*	Bengal	North-East India, Burma, Federated Malay State	6/3 per metre length 8–10 in. wide	E	H	—	
Java Tree Python	do	Java	do.	6/9	E	H	—	
Saigon Python	do.	Indo-China	do.	6/6	E	H	—	
Java Rock Python	*Python reticulatus*	Java	Federated Malay States, Sarawak, British North Borneo, Burma	8–12 in. 7/6 metre length about 20/– skin	E E E	H H H	Ular Sawah, Ular Santja, Sawah-n-etem	Common, aquatic, nocturnal. Eggs laid August

A. 2. SNAKES—(*contd.*)

Asia (*contd.*)

Trade name.	Scientific name.	Origin of present supplies.	Empire Countries in which found	Current value. Price per skin or unit length for width stated.	Eggs or Young	Venomous or Harmless.	Local names.	Remarks.
?	*Python curtus*	Sumatra	Federated Malay States, Sarawak, British North Borneo	7/- metre all widths	E	H	—	Swamp dweller
Baby Python	*Eryx conicus*	India	West and South India	1*d* skin nom	E	H	Earth boa	Dry regions
"Indian Cobra Female" (sic)	*Natrix piscator*	India Indo-China	Burma, India, Federated Malay States, Ceylon	6*d* skin	E	H	Chequered keel-back	Aquatic—Fresh waters. Pairing Oct.–Mar.; eggs laid Nov.–May
Indian Rattle-snake (sic), Whip Snake	*Ptyas mucosus*	India	Ceylon, India, Burma, Federated Malay States	1/- skin	E	H	Dhaman, rat-snake	Breeding season June–Dec.
Java Totak	*Zaocys carinatus*	Java	Federated Malay States, Sarawak, British North Borneo	2/- skin	E	H	—	—
Ribbon Snake	*Helicops schistosus*	India	South India, Ceylon	1*d*. skin	E	H	Olive keel-back	Breeding season Aug.–Apr.
Karung	*Acrochordus javanicus*	Dutch East Indies	Federated Malay States, Sarawak, British North Borneo, British and North-East New Guinea	Width / Price per skin 10–14 cm. 9*d* 15–17 1/6 18–19 2/3 20–24 4/6 25–29 5/6 + 30 up 7/6	Y	H	Ular belalei gajah	Aquatic, fresh waters
Karung Type	do.	do.	do.	All sizes 6*d* skin				
Philippine Water Snake	*Chersydrus granulatus*	Philippines	Federated Malay States, Sarawak, British North Borneo, India, Ceylon, Burma, British and North-East New Guinea	2*d*. skin nom.	Y	H	Ular laut (= sea snake)	Aquatic, estuarine and coastal. Breeding season Apr.–Aug. (India)

A. 2. SNAKES—(*contd.*)

ASIA—(*contd.*)

Trade name	Scientific name	Origin of present supplies	Empire Countries in which found	Current value. Price per skin for width stated.	Eggs or Young.	Venomous or Harmless	Local names	Remarks
Aerwater Snake (Small Grain)	*Homalopsis buccata*	Indo-China	South Burma Federated Malay States, British North Borneo, Sarawak	cm 10–14 3*d*–4*d* 15–19 6*d*–7*d* 20 up 1/-	Y	Ven. (not dangerous)	Ular kadut	Aquatic, rivers and estuaries
Java Water Snake	do	Java	do	10–14 2*d*–1½*d* 15–19 4*d*	Y	do	—	—
Aerwater Snake, Choury	*Enhydris bocourti*	Indo-China	Federated Malay States	10–14 8*d* 15–19 1/2 20 up 2/-	Y	do	[illegible]	Aquatic, rivers [illegible]
Schneider's Water Snake	*Enhydris enhydris*	Indo-China	India, Burma Federated Malay States British North Borneo Sarawak	6*d*			Ular [illegible]	Aquatic rivers [illegible]
[illegible] Water Snake	*Cerberus rhynchops*	Dutch East Indies	Ceylon India Burma Federated Malay States British North Borneo Sarawak British and North East New Guinea ( )	3*d*		do		[illegible], creeks [illegible] Ceylon [illegible] July (India)
Kalimangsas	*Boiga dendrophila*	Dutch East Indies	Federated Malay States, British North Borneo, Sarawak	1 6 to 2 -	E		—	[illegible] real nocturnal
Cobra	*Naja naja*	India	India Ceylon [illegible] Malay St[illegible] British North Borneo Sarawak	[illegible] 9*d*	E	Ven (dangerous)	—	Pairing Jan–June; gestation 2½–5 months. Peak of laying season Apr–May (India)
Russel Viper	*Vipera russeli*	India	India, Burma Ceylon	6*d*	Y	do	[illegible]ia	Pairing Dec.–May; gestation about 6 months born May–Nov peak period June–July

A. 2. SNAKES—(*contd.*)

AUSTRALIA

Trade name	Scientific name	Origin of present supplies	Empire Countries in which found	Current value Price per skin for width stated	Eggs or Young	Venomous or Harmless.	Local names	Remarks
Diamond Snake	*Python spilotes spilotes*	Australia	British and North-East New Guinea	7 in 5/– 8 in up 6/6+	E	H	Diamond snake	Confined to coastal districts
Carpet Snake	*Python spilotes variegata*	Australia	—	do	E	H	Carpet snake	Confined to inland districts
Karung	*Acrochordus javanicus*	Dutch East Indies	(*See* Asia—A)	—	Y	H	Elephant's trunk	*Probably rare in tropical Australian rivers*

A. 3. CROCODILES AND ALLIGATORS

Common name.	Scientific name.	Origin of present supplies.	Empire Countries in which found.	Current Value.	Remarks.
Gharial	*Gavialis gangeticus*	India	North India	10*d.*–12*d.* per inch width, per skin (width measured across belly between hard scutes)	—
False Gharial	*Tomistoma schlegeli*	Borneo	British North Borneo, Sarawak		—
West African Crocodile	*Crocodilus cataphractus*	?	Gambia, Sierra Leone, Gold Coast, Ashanti, Nigeria, British Cameroons		—
Johnston's Crocodile	*Crocodilus johnstoni*	?	North Australia		Small species. *Very limited distribution*
Orinoco Crocodile	*Crocodilus intermedius*	Venezuela	—		Confined to Orinoco system
North American Crocodile	*Crocodilus acutus*	Cuba, Mexico, Colombia	British Honduras, Jamaica		—
Siamese Crocodile	*Crocodilus siamensis*	Indo-China	Federated Malay States		*Very rare* in Federated Malay States
Nile Crocodile	*Crocodilus niloticus*	Madagascar	Anglo-Egyptian Sudan, Uganda, Gold Coast, Gambia, Sierra Leone, Ashanti, British Somaliland, Nigeria, British Cameroons, Kenya, Tanganyika Territory, Nyasaland, Rhodesia, Union of South Africa		—
Salt-water Crocodile	*Crocodilus porosus*	India, Ceylon, Burma, Federated Malay States, Indo-China, Borneo	India, Ceylon, Burma, Federated Malay States, British North Borneo, Sarawak, British New Guinea, North-East New Guinea, Solomon Islands, North Australia		—

A. 3. CROCODILES AND ALLIGATORS—(*contd.*)

Common name.	Scientific name.	Origin of present supplies.	Empire Countries in which found.	Current Value.	Remarks.
New Guinea Crocodile	*Crocodilus novæ-guineæ*	?	British and North-East New Guinea	10*d.*–12*d.* per inch width, per skin (width measured across belly between hard scutes)	Fresh waters of New Guinea (as opposed to the preceding species which is estuarine and marine). *Very limited distribution*
Cuban Crocodile	*Crocodilus rhombifer*	Cuba	—		—
Mugger	*Crocodilus palustris*	India, Ceylon, Burma, Federated Malay States	India, Ceylon, Burma, Federated Malay States		
—	*Osteolæmus tetraspis*	?	Sierra Leone, Gold Coast, British Cameroons		Small ; *rare ; limited distribution*
North American Alligator	*Alligator mississippiensis*	United States	—		—
Chinese Alligator	*Alligator sinensis*	?	—		

In the case of the crocodiles and alligators mentioned in this table, no commercial material was examined, as for identification the skulls as well as skins are desirable. In a few cases, as shown, it is doubtful whether the skins are on the market.

The South American Caimans are not suitable for leather.

B. SPECIES FOUND IN EMPIRE COUNTRIES, THE SKINS OF WHICH ARE NOT AT PRESENT COMMERCIALLY COLLECTED BUT ARE WORTHY OF CONSIDERATION

B. 1. LIZARDS (All harmless)

AFRICA

Scientific name.	Empire Countries in which found	Eggs or Young	Local names	Remarks
Varanus exanthematicus albigularis	Tanganyika Territory, Nyasaland, Rhodesia, Bechuanaland, South-West Africa, Union of South Africa	E	White-throated leguaan White-throated monitor White-throated goanna White-throated iguana	—

AMERICA

Scientific name.	Empire Countries in which found	Eggs or Young	Local names	Remarks
Cyclura cristata . .	White Cay	E	Bahaman and Jamaican Iguanas	*All these species are rare, and some may be already extinct Uncontrolled collecting will certainly exterminate the remainder since each species is confined to the small islands mentioned Protection (complete) strongly recommended*
Cyclura figginsi . .	Bitter Guana Cay, Exuma Group	E		
Cyclura collei . .	Jamaica	E		
Cyclura carinata . .	Turks Island	E		
Cyclura nuchalis . .	Fortune Island	E		
Cyclura rileyi . .	Cays near Watlings Island	E		
Cyclura inornata . .	U Cay, near Highborn Cay	E		
Cyclura baeolopha . .	Andros Island	E		
Cyclura caymanensis .	Cayman Brac, Little Cayman	E		
Iguana delicatissima .	St Kitts, Dominica, St Lucia, Grenada	E	Iguana	*Both species used for food and so probably in danger of extermination on these islands*
Iguana rhinolopha . .	Nevis	E	do	

B. 1. LIZARDS (All harmless)—(*contd.*)

ASIA (INCLUDING MALAY ARCHIPELAGO AND NEW GUINEA)

Scientific name.	Empire Countries in which found.	Eggs or Young.	Local names.	Remarks.
Uromastix hardwicki	North India	E	Sanda	—
Gonyocephalus dilophus	British and North-East New Guinea	E	—	Large, crested, arboreal lizards
Gonyocephalus godeffroyi	British and North-East New Guinea, Bismarck Archipelago, Solomon Islands	E	—	do.

AUSTRALIA

Scientific name.	Distribution.	Maximum sizes (approximate)	Eggs or Young.	Local names.	Remarks.
Varanus varius varius	Eastern Districts	6 ft.	E	Lace Monitor	Tree lizard
Varanus varius belli	do.	6 ft.	E	do.	do
Varanus gouldi	All Australia	4 ft.	E	Goulds Monitor	Terrestrial; dry country
Varanus giganteus	Queensland, Northern Territory	7 ft	E	Giant Monitor	Tree lizard (?); *probably rare*
Varanus salvator	Cape York Peninsula	7–8 ft.	E	—	Asiatic species (*See* A 1, Asia);
Varanus indicus	do.	4 ft	E	—	*probably rare in Australia*
Varanus punctatus	West, Central and Northern Districts	2–2½ ft.	E	—	
Varanus timorensis	do.	do.	E	—	*All restricted in distribution*
Varanus acanthurus	do	do.	E	—	
Amphibolurus barbatus	All Australia	2 ft.	E	Jew Lizard, Bearded Lizard	Common
Physignathus lesueurii	Queensland	3 ft.	E	Water Lizard, Water Dragon	Sub-aquatic species

All the above species of Varanus are known as Monitors, Goannas or Iguanas.

B. 2. SNAKES

AFRICA

Scientific name.	Empire Countries in which found.	Maximum sizes (approximate).	Eggs or Young.	Venomous or Harmless.	Local names.	Remarks.
Calabaria reinhardti	British Cameroons, Southern Nigeria	3 ft.	E (?)	H	Two-headed snake	Found among leaves of forest floor, erroneously regarded as very poisonous
Pseudaspis cana	Kenya, Tanganyika Territory, Nyasaland, Rhodesia, Union of South Africa	7 ft.	Y	H	Mole snake	Variable colouring
Grayia ornata	British Cameroons	4 ft	Y (?)	H	—	Aquatic; confined to vicinity of rivers and streams of forest region
Grayia smythii	Sierra Leone, Southern Nigeria, Uganda	5 ft.	Y (?)	H	—	
Grayia cæsar.	British Cameroons	3 ft. 6 in.	Y (?)	H	—	
Dispholidus typus	Gambia, Sierra Leone, Gold Coast, Ashanti, Nigeria, British Cameroons, Sudan, Uganda, Kenya, Tanganyika Territory, Nyasaland, Rhodesia, Union of South Africa	4 ft. 6 in	E	Ven. (not dangerous)	Boomslang	Arboreal. Commoner in East and South; eggs laid Oct.–Dec. (South Africa)
Boiga blandingi	Sierra Leone, Gold Coast, Ashanti, Nigeria, British Cameroons, Uganda	7 ft	E	do	Tree snake	—
Boulengerina stormsi	Tanganyika Territory, Nyasaland	6 ft.	?	Ven. (dangerous)	—	Aquatic cobras, living in and about lakes and streams
Boulengerina annulata	British Cameroons	6 ft	?	do	—	
Dendraspis angusticeps	Kenya, Uganda, Tanganyika Territory, Nyasaland Rhodesia, Union of South Africa	13 ft.	E	do.	Black and Green Mamba	—
Naja melanoleuca	Gambia, Sierra Leone, Gold Coast, Ashanti, Nigeria, British Cameroons, Tanganyika Territory Nyasaland, Rhodesia	9 ft.	E	do.	Black-lipped Cobra	—

B. 2. SNAKES—(*contd.*)

AFRICA—(*contd.*)

Scientific name.	Empire Countries in which found.	Maximum sizes (approximate)	Eggs or Young	Venomous or Harmless.	Local names.	Remarks.
Naja haje	British Somaliland, Anglo-Egyptian Sudan, Uganda	6 ft.	E	Ven (dangerous)	Egyptian Cobra	—
Naja nivea	South Africa	5 ft.	E	do.	Cape Cobra, Yellow Cobra, Geel slang, Bruin slang, Spoeg slang	Pairing Sept.-Oct.
Bitis nasicornis	British Cameroons	4 ft.	Y	do	Rhinoceros viper, River jack	—
Bitis gabonica	Nigeria, British Cameroons, Uganda, Tanganyika Territory, Rhodesia	5 ft.	Y	do.	Gaboon viper	Pairing Oct
Cerastes cornutus	Anglo-Egyptian Sudan, Aden	3 ft.	Y	do	Horned viper	
		AMERICA				
Constrictor orophias	St. Lucia, Dominica	10 ft	E	H	Tête chien	*Rare and found only on these two islands; useful check on mongoose, so recommended for protection*
Boa canina	British Guiana	6 ft.	E	H	—	—
Boa hortulana	St. Vincent, Grenada, Grenadines, Trinidad	7 ft.	E	H	—	*Very rare, restricted in distribution, so recommended for protection*
Boa cooki	Grenada, Trinidad	8 ft.	E	H	Mapanare, Cascabel	Pairing Feb.; gestation six months

B. 2. SNAKES—*(contd.)*

AMERICA—*(contd.)*

Scientific name.	Empire Countries in which found.	Maximum sizes (approximate).	Eggs or Young.	Venomous or Harmless.	Local names	Remarks.
Epicrates striatus	Bahamas (Andros, New Providence)	6 ft.	E	H	Bahaman boa	*Confined to these islands and Haiti, so recommended for protection*
Epicrates subflavus	Jamaica	5 ft.	E	H	—	*Very rare and confined to Jamaica, so recommended for protection*
Drymobius margaritifer	British Honduras	4 ft.	E	H	—	—
Phrynonax pœcilonotus	British Honduras, British Guiana, Trinidad	7 ft.	E (?)	H	—	*Rare in Trinidad*
Drymarchon corais corais	British Guiana, Trinidad, Tobago	9 ft.	E	H	Cribo	*Rare in Trinidad*
Drymarchon corais couperi	British Honduras	9 ft.	E	H	—	—
Chironius carinatus	British Guiana, Trinidad	6 ft	E	H	Machete	—
Pseudoboa clœlia	British Guiana, Trinidad, Dominica, Grenada	7 ft	E	Ven (not dangerous)	Mussurana, Black cribo, Vidua	*Preys almost exclusively on venomous snakes, so recommended for protection*
Bothrops atrox	British Guiana, Trinidad, Tobago, St. Lucia	6 ft.	Y	Ven. (dangerous)	Fer de lance, Mapepire balsain, Caissaca	Young born Sept.–Jan.

B. 2. SNAKES—(*contd.*)

ASIA (INCLUDING MALAY ARCHIPELAGO, NEW GUINEA AND MELANESIA). Section I. Land and fresh-water snakes

Scientific name.	Empire Countries in which found	Maximum sizes (approximate)	Eggs or Young.	Venomous or Harmless.	Local names.	Remarks.
Python amethystinus	British and North-East New Guinea, Bismarck Archipelago	21 ft.	E	H	Queensland python	—
Python spilotes	British New Guinea	14 ft	E	H	Diamond snake	—
Chondropython viridis	British and North-East New Guinea	6 ft.	E (?)	H	Green tree-python, Yamomong	Arboreal, nocturnal
Nardoana boa	British and North-East New Guinea, Bismarck Archipelago	5 ft.	E (?)	H	—	Nocturnal
Liasis papuanus	British and North-East New Guinea	11 ft.	E	H	Rock snake	—
Liasis albertisi	do	8 ft.	E	H	Rock snake	—
Enygrus asper	British and North-East New Guinea, Bismarck Archipelago	5 ft.	E	H	—	—
Enygrus carinatus	British and North-East New Guinea, Bismarck Archipelago, Solomon Is.	4 ft.	E	H	—	Arboreal. Very varied markings.
Enygrus bibroni	Bismarck Archipelago, Solomon Is., New Hebrides, Samoa	4 ft.	E	H	—	—
Natrix trianguligerus	Burma, Federated Malay States, British North Borneo, Sarawak	4 ft. 6 in	E	H	Ular tjahe	Sub-aquatic; fresh waters
Dinodon septentrionalis	Burma, Assam	4 ft. 6 in.	E	H	—	—
Stegonotus reticulatus	British and North-East New Guinea, Bismarck Archipelago	4 ft.	E	H	—	—
Ptyas korros	North India, Burma, Federated Malay States, British North Borneo, Sarawak	6 ft.	E	H	Rat-snake	—
Zaocys fuscus	Federated Malay States, British North Borneo, Sarawak	9 ft.	E	H	—	—

B. 2. SNAKES—(*contd.*)

ASIA.—Section I (*contd.*)

Scientific name.	Empire Countries in which found.	Maximum sizes (approximate)	Eggs or Young.	Venomous or Harmless.	Local names.	Remarks.
Elaphe oxycephala	Assam, Burma, British North Borneo, Sarawak, Federated Malay States	7 ft.	E	H	Ular bangka laut Ular bamban	—
Elaphe melanura	do.	6 ft.	E	H	Ular babi	—
Elaphe radiata	North-East India, Burma, Federated Malay States	5 ft.	E	H	Ular tikus	—
Gonyophis margaritatus	British North Borneo, Sarawak	5 ft.	E	H	—	—
Fordonia leucobalia	Federated Malay States, British North Borneo, Sarawak, British and North-East New Guinea	4 ft.	Y	Ven. (not dangerous)	— —	Estuarine and marine. *Rare*
Boiga irregularis	British and North-East New Guinea, Bismarck Archipelago, Solomon Is.	7 ft.	E	do.	Cat-snake	Arboreal
Boiga cynodon	Assam, Burma, British North Borneo, Sarawak, Federated Malay States	8 ft 6 in.	E	do.	do.	Arboreal. Variable colour
Boiga forsteni	India, Ceylon	8 ft.	E	do.	do. Mapila, Le polonga	Arboreal. Eggs laid Aug.–Sept Variable colour
Bungarus fasciatus	India, Burma, British North Borneo, Sarawak, Federated Malay States	5 ft.	E	Ven. (dangerous)	Banded krait, Ular Welang	—
Bungarus flaviceps	Federated Malay States	6 ft.	E	do	Yellow-headed krait	—
Naja hannah	India, Burma, British North Borneo, Sarawak, Federated Malay States	18 ft.	E	do.	Hamadryad, King cobra, Ular tedong sélar	—

B. 2. SNAKES—(*contd.*)

ASIA (INCLUDING MALAY ARCHIPELAGO, NEW GUINEA AND MELANESIA). Section II. Sea-snakes

Scientific name.	Empire Countries in which found.	Maximum sizes (approximate)	Eggs or Young.	Venomous or Harmless.	Local names.	Remarks.
Laticauda colubrina	Bengal to North Australia, and Fiji	4 ft 6 in.	E	V	Ular laut	—
Aipysurus eydouxi	Coasts of Federated Malay States, British North Borneo, Sarawak, British New Guinea	3 ft.	Y	V	do.	—
Aipysurus lævis	Coasts of British and North-East New Guinea and neighbouring reefs	5 ft	Y	V	do.	—
Aipysurus duboisi	do	4 ft.	Y	V	do.	—
Kerilia jerdoni	Coasts of Ceylon, East India, Burma, Federated Malay States	3 ft.	Y	V	do Shiddil (Tamil)	Young born July–Nov. (?)
Thalassophina viperina	All coasts of India, Ceylon, Burma, Federated Malay States, British North Borneo and Sarawak	3 ft.	Y	V	—	—
Enhydrina schistosa	All coasts of India, Ceylon, Burma, Federated Malay States, British North Borneo and Sarawak, British and North-East New Guinea	5 ft.	Y	V	Valakadyen (Tamil) Hoogly pattee	Young born Feb.–May (India)
Hydrophis nigrocinctus	Coasts of Bengal, Burma	4 ft.	Y	V	—	—
Hydrophis spiralis	All coasts of India, Ceylon, Burma, Federated Malay States, British North Borneo and Sarawak	9 ft.	Y	V	Kadel nagam, Kadel pambu	Young born Feb.–Aug. (India)
Hydrophis cyanocinctus	All coasts of India, Ceylon, Burma, Federated Malay States, British North Borneo and Sarawak	6 ft.	Y	V	Chittul	—

B. 2. SNAKES—(*contd.*)

ASIA. Section II (*contd.*)

Scientific name.	Empire Countries in which found.	Maximum sizes (approximate).	Eggs or Young.	Venomous or Harmless.	Local names.	Remarks.
Hydrophis klossi	Coasts of Federated Malay States	4 ft. 6 in	Y	V	—	—
Hydrophis stricticollis	Coasts of Bengal and Burma	4 ft.	Y	V	—	—
Astrotia stokesi	Coasts of India, Ceylon, Burma, Federated Malay States. British North Borneo and Sarawak	6 ft.	Y	V	—	Young born Nov. (?)
Pelamis platurus	All tropical and sub-tropical coasts in Indian Ocean and the Pacific	3 ft.	Y	V	Black and yellow sea-snake	Young born April (India)
Microcephalophis cantoris	Coasts of India, Ceylon, Burma, Federated Malay States	6 ft.	Y	V	—	Young born Oct. (?) (India)

All the species in this Section are Sea-snakes, strictly aquatic and marine. Known indiscriminately by Malays as *Ular laut*. All venomous and may be dangerous. Should be obtainable in quantities from native fishermen who, at present, throw them back into the sea.

B. 2. SNAKES—(*contd.*)

AUSTRALIA

Scientific name.	Other Empire Countries in which found.	Maximum sizes (approximate)	Eggs or Young.	Venomous or Harmless.	Local names.	Remarks.
Liasis olivaceus	—	5–6 ft.	E	H	Rock snake	*Confined to Northern Australia, and rare; recommended for protection*
Liasis fuscus	British and North-East New Guinea	7–8 ft.	E	H	Brown rock snake	*Rare in Northern Australia*
Liasis albertisi	do.	8 ft.	E	H	d'Alberti's rock snake	do.
Liasis childreni	—	7 ft.	E	H	Common rock snake	Northern Territory and Queensland
Python amethystinus	British and North-East New Guinea, Bismarck Archipelago	21 ft.	E	H	Queensland python	do.
Aspidites melanocephalus	—	8 ft.	E	H	Black-headed rock snake	—
Aspidites ramsayi	—	8 ft.	E	H	Woma	Common, widespread
Demansia nuchalis	—	5 ft.	E	Ven. (dangerous)	Collared brown snake	—
Demansia olivacea	British and North-East New Guinea	4 ft.	E	do.	—	Northern Territory and Cape York
Demansia affinis	—	5 ft.	E	do.	Spotted brown snake	Central Australia; *rare*
Demansia psammophis	British and North-East New Guinea	6 ft	E	do.	Yellow whip-snake	Eggs laid Dec.
Demansia textilis	—	6 ft.	E	do.	Common brown snake	Common, widespread
Pseudechis microlepidotus	—	7 ft.	Y	do.	—	—

B. 2. SNAKES—(*cont.*)

AUSTRALIA (*cont.*)

Scientific name.	Other Empire Countries in which found.	Maximum sizes (approximate).	Eggs or Young.	Venomous or Harmless.	Local names.	Remarks.
Pseudechis australis	—	6 ft	Y	Ven. (dangerous)	Mulga	—
Pseudechis cupreus	—	6 ft.	Y	do.	Copper snake	Common in eastern coastal districts; young born, Mar.
Pseudechis prophyriacus	—	7 ft.	Y	do.	Red-bellied black snake	—
Pseudechis mortonensis	—	5 ft.	Y	do.	Blue-bellied black snake	—
Pseudechis darwiniensis	—	6 ft.	Y	do.	Brown snake	*Very restricted distribution*
Pseudechis ferox	—	7 ft.	Y	do.	White-bellied black snake	do
Pseudechis scutellatus / *Oxyuranus maclennani*	—	10 ft.	Y	do.	Giant brown snake	*Very rare and restricted in distribution*
Notechis scutatus	—	6 ft	Y	do.	Tiger snake	—
Denisonia superba	—	5 ft.	Y	do.	Copper-head	—
Hoplocephalus bungaroides	—	5 ft.	Y	do.	Yellow-spotted snake	—

A number of the Sea-snakes listed under "ASIA—B" occur in tropical Australian waters.
The following are the two largest exclusively Australian sea-snakes:

Scientific name.	Other Empire Countries in which found.	Maximum sizes (approximate).	Eggs or Young.	Venomous or Harmless.	Local names.	Remarks.
Hydrophis elegans	—	6 ft. 6 in.	Y	Ven. (dangerous)	—	—
Hydrophis major	—	5 ft.	Y	do.	—	—

THE NUTMEG INDUSTRY

The position of the nutmeg industry of Grenada has been receiving considerable attention in recent years, both from the local trade organisation (the Grenada Spice Association) and the Spice Commission appointed by the Grenada Government. The Imperial Institute, at the request of the Empire Marketing Board, prepared for the Grenada authorities, in August 1931, a survey of the industry, including a discussion of the competition with nutmegs from the Dutch East Indies, the principal defects of Grenada nutmegs as then marketed, and the directions in which improvements might be effected. This memorandum is printed in the following pages, together with additional information which was subsequently furnished regarding the stocks of nutmegs in London, the possible trend of the market and the room for increased production. The statistical tables appended to the memorandum have been brought up to date as far as possible.

The Spice Commission, under the chairmanship of Mr. John R. Munro, have submitted to the Grenada Government a report, dated March 20, 1933, on the nutmeg industry of the island. As a result of their investigations the Commission find that, apart from the low prices at present ruling, which are solely caused by the world-wide depression, the industry is on the whole satisfactory, and they are of opinion that there is no necessity for the local Government to render any financial assistance. They recommend very strongly that shippers of nutmegs should give the matter of grading their most careful attention, and that, in the case of mace, greater care should be exercised in packing in order to ensure complete uniformity of colour. The Commission finally draw attention to the question of packages for nutmegs and are of opinion that whenever shipments are made on consignment, only uniform packages should be used and that this procedure should be gradually extended to include contract shipments.

Information has recently been received that more attention is being given to grading nutmegs in Grenada and that consignments now arriving in London show a

distinct improvement over the sample taken in 1931, which is represented in the illustration (Plate IX).

Memorandum on the Nutmeg Industry with Special Reference to the Trade of Grenada

Prepared at the Imperial Institute and furnished to Grenada, through the Empire Marketing Board.

The well-known spices Nutmegs and Mace are produced by *Myristica fragrans*, a handsome, evergreen tree, native to some of the Moluccas, which were early known as the Spice Islands owing to the occurrence of nutmeg and clove trees.

The nutmeg tree is usually unisexual, male and female flowers being borne on separate plants. The female trees bear the fruits, which in shape and colour somewhat resemble nectarines. When ripe a fruit splits into two fleshy halves, setting free the nutmeg enclosed in a thin, hard, dark brown, shining seed coat, the shell, over which and attached to its base is a beautiful crimson fleshy network, the mace.

Nutmegs and mace are used directly as spices, and as the sources of fragrant essential oils. The seeds, i.e. the nutmegs, also yield nutmeg butter, which is of about the consistency of soft tallow, almost white and has the strong taste and odour of nutmegs. It is used chiefly in the manufacture of some soaps. The essential oil distilled from the nuts has a restricted use as a flavouring agent and in perfumery. The fleshy husks of the ripe fruits are used to some extent for making into nutmeg jelly and other preserves.

Nutmegs and mace appear to have been known in Constantinople as spices about A.D. 540, and are recorded as being used in Rome towards the close of the twelfth century. The Portuguese held a monopoly of these spices until 1605 when they were expelled from the Moluccas by the Dutch. The latter attempted to confine the cultivation of the tree to the islands of Amboyna and Banda. Later, for a short period, the Banda Islands passed under the control of the East India Company, who in their

turn secured a practical monopoly. W. Milburn "of the East India Company's service" gives in *Oriental Commerce,* published in 1813, interesting figures of the sales of nutmegs during part of the time the Banda Islands were in British possession :

1803	104,094 lb.	£46,233
1804	117,936 ,,	£54,733
1805 (part)	35,851 ,,	£33,742

Previously the East India Company had attempted to break down the monopoly of the Dutch, and from 1796 onwards they introduced nutmegs and cloves into Penang, which had been founded ten years before. By 1802 it is recorded that 71,266 nutmeg and 55,265 clove plants had been sent to Penang and planted in the Company's spice gardens or distributed to planters. The results were not very successful and in 1805 the East India Company sold its spice gardens. Some planters, however, persevered, and it is recorded that in 1850 there were 24 plantations containing some 56,000 nutmeg trees, and Penang and Province Wellesley nutmegs obtained a high reputation for their superior quality. From 1836 onwards the plantations were troubled by a disease which increased in severity until by about 1860 they were almost wiped out. The cultivation was restarted later, but was put into the background by the successful introduction of Hevea rubber, so that nutmegs are now only a crop of minor importance in British Malaya.

Subsequent to the introduction of the nutmeg into Penang the tree was widely distributed and to-day it is to be found in botanic gardens, or grown on a small scale for local use and sometimes for export to a limited extent, in many tropical countries where conditions are suitable. In some of the West Indian islands the nutmeg found congenial conditions and, particularly in the island of Grenada, its cultivation reached commercial importance and began "first to influence the market in from 1865 to 1874."

To-day the principal sources of the world's supply of nutmegs are the Dutch East Indies and Grenada. A general view of the position is given in Diagram I. During the nine years 1921 to 1929 the annual exports of nutmegs

NUTMEGS

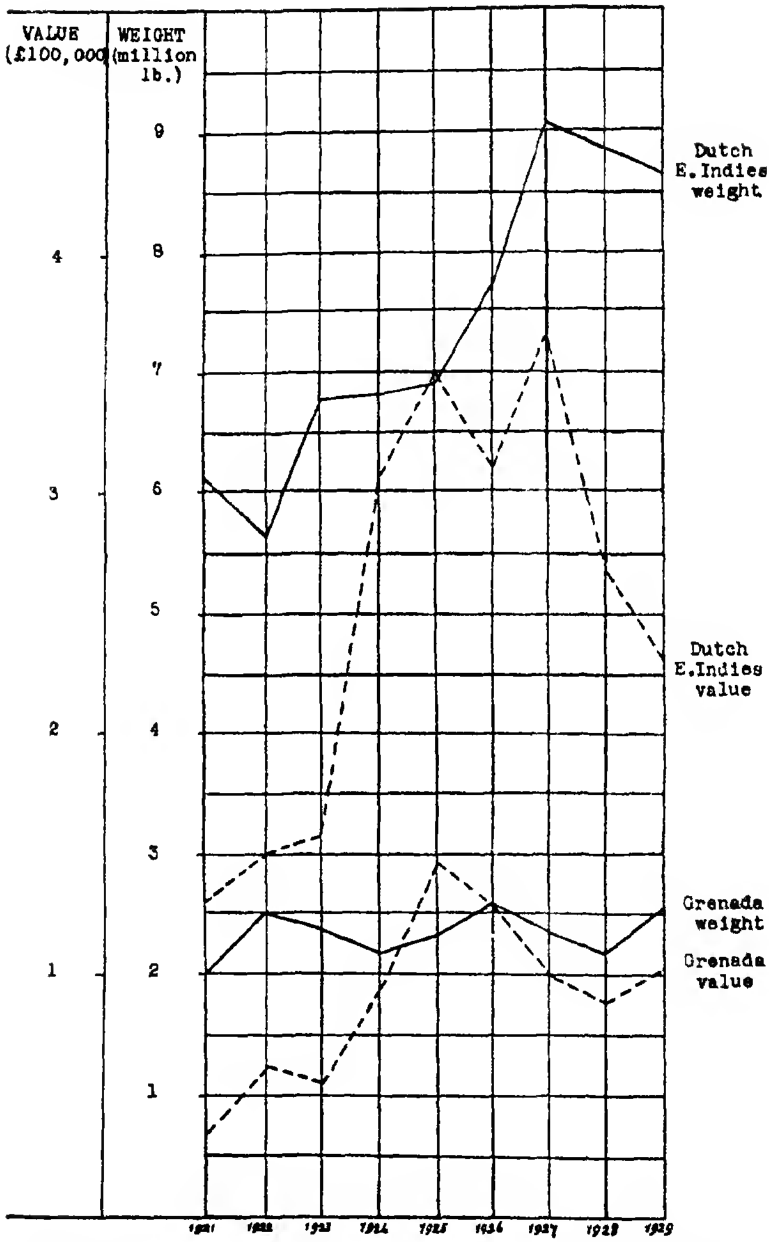


DIAGRAM I.—Quantity and value of exports from Dutch East Indies and Grenada, 1921-29.

from the Dutch East Indies have ranged from about 6,000,000 lb. to 9,000,000 lb. The Grenada exports in the same period have been between 2,000,000 lb. and 2,500,000 lb. per annum. The same diagram shows also the total value, in pounds sterling, of the exports of the two countries. Particulars of both quantities and values are given in statistical Tables I and II.

The Dutch East Indies

The Dutch East Indies are the principal source of the world's supplies of nutmegs and mace, although in trade returns Singapore appears as the chief port of origin The reason for this is explained in the following extracts from *Special Circular* 310 (1930), Foodstuffs Division of the United States Bureau of Foreign and Domestic Commerce :

" Nutmegs are cultivated in Java to some extent, there being about thirteen plantations where they are produced. The planted area in production in that island during the year 1927 was approximately 1,684 acres. In the whole Netherland East Indies during that year estate production of nutmegs involved about 3,846 acres, exclusive of the native cultivations on the Banda Islands. A large production comes from the Banda Islands, almost all of which are planted with nutmegs. The West Coast of Sumatra is also a producer of this spice.

" Singapore receives its nutmegs and mace for re-export from the Celebes and Moluccas, Sumatra, Java and Siam, their importance as producing countries in this territory being in the order named. The Celebes and Moluccas produce on an average 90 per cent. of the nutmegs imported into Singapore ; Java and Sumatra furnish 9 per cent. and the balance comes from other countries, largely from Siam.

" The Singapore market takes an average of more than three-fourths of unshelled nutmegs from the Moluccas. These nutmegs are imported by about twenty-five small Chinese dealers in Singapore who in turn sell to four Chinese firms, jobbers, so to speak, that shell and grade them for the export market. From these four firms in Singapore the European export houses secure their shelled

nutmegs. One Chinese export house also competes in this market, and in 1928 became an important exporter of nutmegs, shipping entirely, however, to European markets.

"Statistics in regard to the movement of nutmegs into and from British Malaya show that a larger quantity are imported than are exported. The explanation of this apparent disparity, since Singapore is mainly a re-exporting point, lies in the fact that nutmegs are almost invariably imported into British Malaya in the shell, and are exported without shell. The loss from these cleaning operations is estimated to average 25 per cent."

Grenada

In Grenada the nutmeg thrives in the elevated districts of high rainfall. Whilst there are some estates mainly devoted to nutmegs, a large proportion of the crop is obtained from trees interplanted amongst cocoa on estate and peasant holdings. For many years it has been the practice, especially when the price of cocoa is low, to plant nutmegs in places where cocoa trees have failed. Now and again the reverse policy has been adopted, the nutmegs being cut back when the price for the spice has been low or that of cocoa unusually high.

On the whole, however, the nutmeg has been a very important factor in the agricultural prosperity of Grenada, as shown by the following summary of comments on this crop which have appeared in the Annual Reports of the Department of Agriculture from 1907 onwards.

1907–8. The very low prices have induced many planters with mixed cultivation to cut back nutmegs for cocoa.

1914–15. Although the area under nutmegs is not being extended the crop has almost doubled during the last ten years, chiefly due to the increased cropping capacity of maturing trees.

1915–16. The season has been favourable and the exports show an upward tendency. The high prices during the first half of 1916 will probably result in every nut being carefully harvested.

1916–17. The records of the last six years show a steady upward tendency.

1919. The season has been favourable and the market good and steady. Trees on some mountain areas, planted during the last six or seven years, are now coming into bearing.

1922. The nutmegs bore remarkably well and prices were good. " Alarmists who maintained that nutmeg groves were ruined by the hurricane of 1921, express surprise at the heavy crops which give promise of continuing into 1923."

1923. Spices are the mainstay of the agriculturist, and very good prices prevailed throughout the year. " The cultivation of the nutmeg is being pushed on all sides, and estates are extending their cultivation wherever practicable." This year's crop was the largest on record and has been reaped in the second year after the hurricane of 1921.

1924. Nutmegs and mace more than hold their own and " have been without doubt the upkeep of the community." Plantings are still being extended wherever practicable. " Nutmegs, sound, unassorted soared to as high levels as 40 cents. This has been ahead of all war prices. The crop was good and most foreign orders to the majority of business houses had to be accompanied by a letter of credit."

1925. Pale yellow mace fetched 74 cents, and sound unassorted nutmegs 40 cents. Several holdings with mortgages on them have paid off their liabilities.

1929. The nutmeg crop continues to increase and the healthy state of the market has aroused greater interest in this crop.

The importance of the nutmeg tree as a factor in the progress of Grenada during the last fifty years is very clearly indicated in the following extracts from the historical summary of the Colony as given in the 1881 and 1925 editions of the *Grenada Handbook.*

1881. " During the ten years from 1871, the change in the agricultural system of the island originally brought about by the emancipation of the slaves (1833–4) had been rapidly progressing. Sugar having ceased to be a remunerative article of export under the conditions of labour in Grenada, numbers of estates had been abandoned, and

after an interval they were sold out in small lots to the former labourers, who cultivated them in cacao and nutmegs. The change that had gradually taken place can best be estimated by comparing the exports of sugar and cacao in 1846 with those of 1881. In 1846, 9,196,538 lb. of sugar and 374,686 lb. of cacao left the island; in 1881, the cacao exported amounted to 5,864,000 lb., as against 2,038,712 lb. of sugar, besides which the spices exported amounted to nearly 1,000,000 lb."

1925. "The year 1925 proved to be one of the most prosperous in the history of Grenada. All the principal crops were greater in value than in the previous year and the increases in quantity occurred in a period of greatly enhanced prices. Especially was this so in the case of the nutmeg crop and its derivative mace. So substantial was the rise in value of these two products that they challenged cacao for the premier position on the scale of exports, the combined exports value for the calendar year 1925 being £185,647, while the value of cacao which for so long a period had far exceeded the total of all the other exports was £197,231. A decade previously cacao accounted for 85 per cent. of the exports according to value, and nutmegs and mace came second, representing 10 per cent. The percentages in 1925 were 45·4 and 42·7 respectively. . . . A comparison of the development of the Colony at the end of the first quarter of the present century and at the opening of the century is given in the following analysis:

	Year 1900.	Year 1925
Cacao crop reaped . . .	53,388 bags	45,556 bags
Nutmeg crop reaped . .	5,886 cwt	21,762 cwt
Mace crop reaped . . .	799 ,,	3,843 ,,
Cotton crop reaped . .	2,628 ,,	3,252 ,,

Price Fluctuations

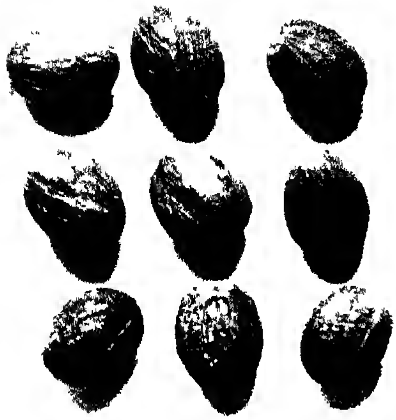
Whilst, as already shown, the production of nutmegs has been of very great importance to Grenada and, indeed, its salvation when the cocoa crop was poor or prices low, the fluctuations in price during the last few years have caused serious misgivings as to whether the full value was being obtained. Suggestions have been made to secure some working arrangement with the producers in the East

Plate IX

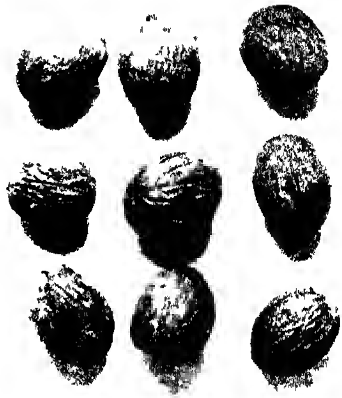
NUTMEGS

Commercial Samples and Comparative Prices

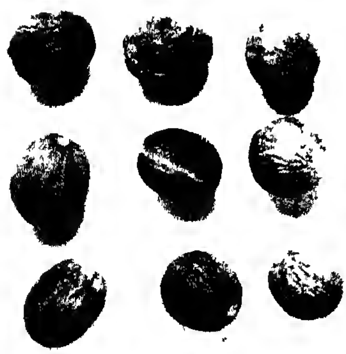
London, March 12, 1931



Dutch East Indies
65's 1s 1d



Dutch East Indies
80's 10½d



Dutch East Indies
110's 9½d

Grenada
Unassorted [illegible]d

(About half natural size)

to control prices. It is pertinent to endeavour to ascertain first whether the Eastern nutmegs, which form by far the larger part of the world's supply, have been subject to similar price fluctuations. In Diagram II are given graphs showing the values of Dutch East Indian and Grenada nutmegs for the period 1921 to 1929. They are based on the export returns of the two countries (Tables I and II). For purposes of comparison the value of 1,000 lb. of shelled cultivated nutmegs from the Dutch East Indies and of the same quantity of nutmegs from Grenada have been taken. The diagram shows that, on the whole, there has been a reasonably close agreement in price fluctuations. Both benefited to practically the same extent by the rapid increase in value in 1924 and 1925 and both have experienced the subsequent steady drop in prices. Assuming that the figures given in the returns fairly accurately represent the prices obtained by producers in the two countries it is doubtful whether much closer agreement would have been obtained if an effective arrangement to control prices had been in operation. If this be so the conclusion must be drawn that Grenada during these years of fluctuating values has obtained the world's price for its nutmegs, which now after a boom period is getting back to what must be regarded as a more normal level.

Long and Round Nutmegs

The prices of Grenada nutmegs in European markets are at present much below those of nutmegs from the Dutch East Indies, known in the trade as "Singapores." This is due to several reasons. The Dutch East Indies nutmegs are all "round," i.e. nearly spherical, light coloured, free from the dark stains due apparently to bruising, and sorted into the recognised trade sizes. Grenada nutmegs on the other hand are usually unassorted into sizes, a considerable number are frequently bruised and stained with dark marks, and, moreover, they include a large proportion of "longs" as opposed to "rounds." The accompanying photograph of representative samples of Dutch East Indian and Grenada nutmegs, with their comparative values in London on the same day, will make these differences clear.

NUTMEGS

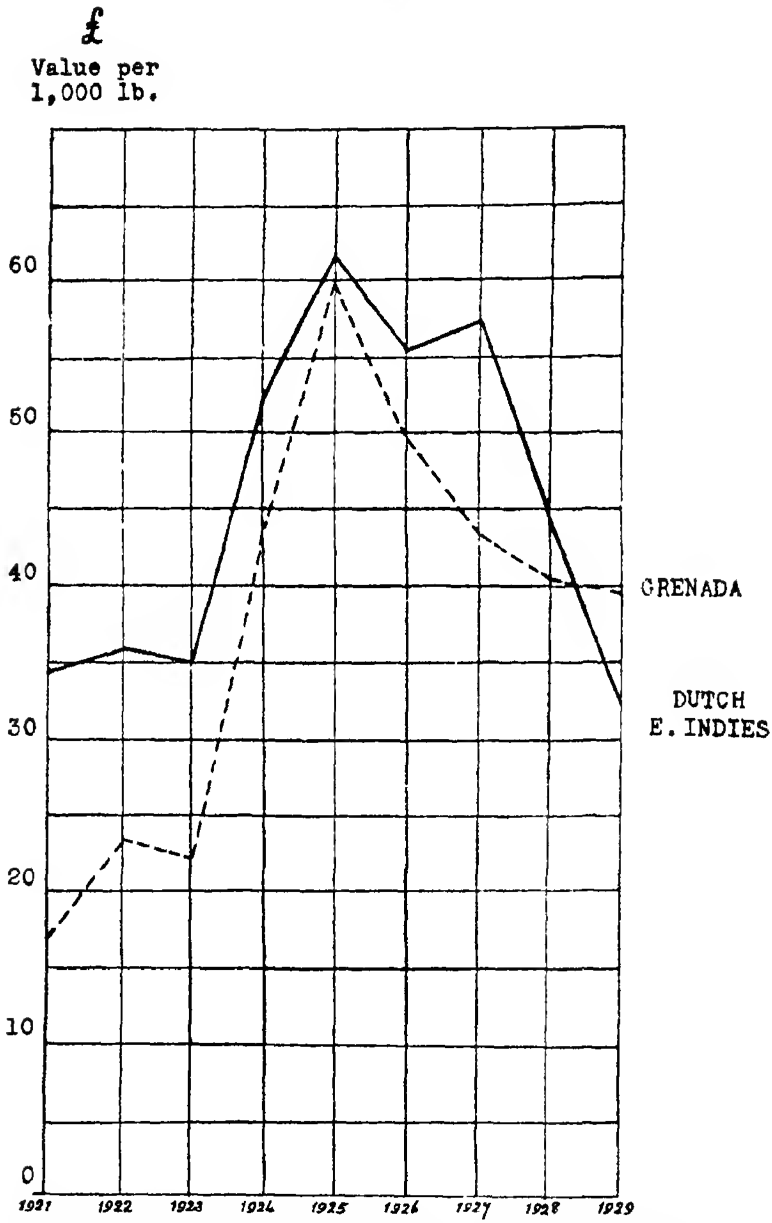


DIAGRAM II.—Values of Dutch East Indies and Grenada Nutmegs per 1,000 lb., based on declared values in official returns of exports (In the case of the Dutch East Indies, the values are for shelled cultivated nutmegs only.)

The range in the London wholesale prices of Grenada nutmegs and the three grades of Dutch East Indies nutmegs is given in No. VII of the appended Tables.

The " long " nutmegs so prevalent amongst the produce of Grenada are particularly disliked in the trade. No evidence was forthcoming that they were in any way inferior in taste, aroma, etc., to " rounds," but merely that they were not liked and were not acceptable for the grocery trade in whole nuts. Accordingly " longs " are relegated with small, wormy and other inferior nuts as suitable only for grinding and command a lower price accordingly.

The reason for this prejudice, for such it seems to be, against long nutmegs may perhaps be found in the following notes from the past history of nutmegs. W. Milburn in 1813 in his book on *Oriental Commerce* already quoted from, says (p. 392) that in the Banda Islands three sorts of nutmeg trees are recognised :

The Male or Barren Nutmeg.

The Royal Nutmeg producing long nuts.

The Queen Nutmeg producing round nuts.

He adds : " Nutmegs should be chosen large, round, heavy and firm, of a lightish grey colour on the outside and the inside beautifully marbled, of a strong fragrant smell, warm aromatic taste, and a fat oily body. . . . The oblong kind and the smaller ones should be rejected."

In 1909 E. M. Holmes, then Curator of the Pharmaceutical Society, contributed a paper to the *Pharmaceutical Journal*, Series IV, Vol. 28, 1909, pp. 419-459, entitled " The Nutmegs of Commerce." He states that Pereira in his *Materia Medica* distinguished two kinds :

(1) The Round, True or Female nutmeg produced by *Myristica fragrans*.

(2) The Long Wild or Male nutmeg produced by *Myristica fatua*.

Subsequently Warburg in the *Berichte der Deutschen Botanischen Gesellschaft*, 1892, 212-217, showed that the Longer or Wild nutmegs could not be the produce of *M. fatua* but were from a hitherto undescribed species to which he gave the name *M. argentea*.

Pereira made a collection of various nutmegs of the world which are still in the Museum of the Pharmaceutical Society where they have been examined in connection with the present enquiry. The Dutch East Indian nutmegs in this collection resemble those seen in commerce to-day, i.e. they are typically round. On the other hand Pereira's specimens of West Indian nutmegs have been subdivided into " rounds " and " longs " just as could be done with a modern commercial consignment. On the question of the quality of nutmegs Holmes says this " depends on their size, and smoothness, and light colour, and in the case of West Indian nutmegs on their freedom from genuine long nutmegs, which may occasionally be found mixed with the oval forms, not that these are of inferior quality, but are liable to be confused with the Papua (New Guinea) or false, long nutmegs of *Myristica argentea*, which are of inferior quality, but much resemble the genuine in external appearance." It seems not improbable that the trade antipathy to long nutmegs is a survival from the days when all the nutmegs of commerce came from the Moluccas, etc., and were liable to contain some admixture of the wild long nutmegs which were markedly inferior to the true round nutmegs. Be this as it may, the fact remains that the market value of Grenada nutmegs is depreciated by the proportion of " longs " they contain. It will probably be difficult to change the views of the trade and equally so to alter the shape of the nutmegs borne by the existing trees in Grenada. Steps might well be taken, however, to ascertain whether long and round nutmegs are borne on the same or different trees, and in the latter event to use only trees bearing nuts of the approved shape as the source for future plantings both for new cultivation or the gradual replacement of undesirable trees. An investigation along these lines to ascertain the facts is commended to the attention of the Grenada Agricultural Department.

Suggested Improvements

To turn now to the defects which appear to be remediable. An undue proportion of Grenada nutmegs are frequently marked with stains. Dealers described them as being often " hopelessly bruised." Such stains

are usually regarded as due to lack of care in shelling. J. H. Hart drew attention to this trouble in the *Trinidad Royal Botanic Gardens Bulletin*, 1892, No. 16. In describing the method of shelling he stated it should be done by a sharp blow on the nuts *placed on end.* " If hit on the side the blow is at once shown upon the side of the nut—a black spot quickly forming, owing to the rupture of the surface cells which contain a considerable proportion of oil."

The other important defects, frequently but not always present, are due to lack of grading and sizing. Many parcels of Grenada produce contain nutmegs of all shapes (i.e. longs and rounds) and sizes, including not only an admixture of the ordinarily recognised sizes but very small nuts, and wormy and broken nuts. The three latter categories should be separated by " garbling," and the sound nuts coming within the recognised trade sizes should also be sorted into their respective classes.

According to information received in the course of this enquiry, Grenada nutmegs were formerly sorted into sizes much more frequently than is the case to-day. It is during the last few years that it has become the more general practice for them to be exported unassorted. The task can of course be performed in England or other countries to which exported, but with the lower cost of labour in Grenada it would presumably be cheaper to size them in the Colony before export.

Another matter of minor importance to which attention might well be given is that of packages. At present Grenada nutmegs are received in all sorts of containers including, as mentioned by one dealer, even such an unwieldy thing as an old pianoforte packing case.

These various points were brought forward in the course of discussion with Mr. C. Howe of Messrs. Paines and Reid, Mr. King of Messrs. Jonas Browne and Son, Mr. Garrard and Mr. Harker of Messrs. Niemann and Co. Subsequently, Messrs. Paines and Reid, after consulting others interested in the matter, kindly put their recommendations forward in a letter from which the following is an extract :

" The qualities of West Indian nutmegs most saleable

for this market are *good light colour and round,* and should be graded into sizes of 110, 80, 60/65 to the pound. It is most essential that the long nutmegs should be picked out and shipped separately, otherwise it will be impossible to compete with Singapores (i.e. Dutch East Indian nutmegs). As regards packing it is advisable to ship in barrels or cases containing about 1 cwt."

Mace

Mace, as previously stated, is the fleshy net-like covering which envelops the seed (i.e. the nutmeg enclosed in its horny shell) and is exposed when the ripe fruit splits open. When fresh it is of a brilliant red colour and rather tough and leathery in texture. Being attached to the seed at the base only, the mace is easily removed by hand and with care can be taken off in one or two pieces. Carelessly handled it will break up into several smaller portions which lowers its market value. The mace after removal is flattened out and placed in the sun to dry. By this operation it becomes horny and its colour gradually changes from light crimson to orange and finally to pale orange-brown or brownish-yellow. Great care must be taken to prevent the mace becoming mouldy or its value will be greatly depreciated.

For export, mace should be packed in good close cases, without cracks or other openings, to prevent accidental damage by water during transit.

As with nutmegs the principal countries of production of mace are the Dutch East Indies and Grenada. During the ten years 1921 to 1930 the exports from the Dutch East Indies have averaged 512 tons per annum, whilst those from Grenada have averaged 171 tons. Part of the output from the Dutch colonies goes to Singapore and is thence exported to other countries. Particulars of the exports from the Dutch East Indies and Grenada, of the imports into and exports from British Malaya, and the imports into the United States are given in the accompanying tables, Nos. VIII to XI.

The principal character which determines the market value of mace is its colour. For the grinding trade pale coloured mace is mostly in demand, and the Grenada

product has an advantage in this respect as the Dutch East Indies mace does not bleach to the desired standard.

Comparative market quotations for mace from the two producing regions are given below :

GRENADA AND DUTCH EAST INDIES MACE

London Wholesale Prices

(From *The Grocer*)

	Grenada. per lb. s. d. s. d.	Dutch East Indies per lb. s. d. s. d.		Grenada. per lb s. d. s d.	Dutch East Indies. per lb. s. d. s. d.
1933	not quoted	1 9–2 2	1929	4 0–4 9	4 0–4 3
1932	2 3–3 6	1 9–2 2	1928	3 9–4 6	3 9–4 6
1931	1 6–2 4	1 9–2 2	1927	3 9–4 6	3 9–4 6
1930	2 6–2 10	2 6–2 10	1926	4 9–5 3	4 9–5 3

Supplementary Information furnished by the Imperial Institute in October 1931

It has been ascertained from Mr. H. J. J. Freeman, a member of a firm of West Indian merchants and planters (themselves producers of nutmegs in Grenada), that he was closely associated with Mr. J. Munro, Chairman of the Grenada Government Commission on Nutmegs, in enquiries as to stocks held and related matters. The conclusion reached was that, outside London, stocks are not large although some may be held in New York. Mr. Munro went to a great deal of trouble in endeavouring to obtain figures for Holland, but was not successful in securing data which he regarded as reliable. Subsequent enquiries have been no more profitable.

As regards the London position, there were in stock on September 22, 1931, 294 packages and 2,330 cwt. The average weight of a package is about 1¾ cwt., so that the total stocks amounted to about 2,850 cwt. The corresponding figures at the same time in 1930 were 489 packages and 3,057 cwt., or a total of about 3,932 cwt.

The imports during the 8½ months from January 1, 1931, were 5,837 cwt., compared with 3,940 cwt. in the corresponding period for 1930. That is to say, whilst the imports were up by approximately 2,000 cwt., the stocks

were about 1,100 cwt. down, from which it appears that the consumption had increased.

The questions of possible trend of the market and room for increased production may be considered together.

From Diagram I of the Memorandum it will be seen that the output of Grenada is comparatively steady for the nine years shown, although it is now several times greater than in 1900. This is in keeping with the fact that in Grenada nutmegs are planted more or less steadily where cocoa is failing. This process is still continuing and a steady but slow increase in the Grenada output may be expected.

Turning to the Dutch East Indies figures in the same diagram it will be seen that following very quickly on the phenomenal increase in the price of nutmegs, 1923–4, continued during 1924–5, there was an almost equally phenomenal increase in the production in 1925–6 and 1926–7. As the nutmeg tree takes about seven years to come into bearing it seems to be indicated that in the Dutch East Indies there are large numbers of nutmegs potentially available but only collected when the price is attractive. This condition of affairs is well known in Grenada also, as indicated by the note in the Memorandum (see p. 202) that "the high prices during the first half of 1916 will probable result in every nut being carefully harvested."

It would not appear advisable, therefore, to recommend to Grenada that any special efforts should be made to increase production. The position would be altered if any new use could be found which would lead to a demand for large quantities of nutmegs. Failing this it would seem preferable to leave Grenada to carry on its normal expansion of nutmeg production which is determined largely by the demand for that crop and the vicissitudes of cocoa.

Statistical Appendix

Complete statistics of the production of nutmegs are not available, but the exports from Grenada and the Dutch East Indies given in the appended tables represent practically the entire amount entering world trade. Most of the nutmegs exported from the Dutch East Indies are

shipped to Singapore and the Netherlands, whence they are re-exported wholly or in part to other countries.

The imports of nutmegs into the United Kingdom and several other important countries are not given separately in the official trade returns. The imports into the Netherlands, the United States and Canada are available, however, and are included in the tables. The available statistics for mace are also given.

Tables

NUTMEGS

I. Grenada: Domestic Exports of Nutmegs, 1921–32.
II. Dutch East Indies: Exports of Nutmegs, 1921–32.
III. British Malaya: Imports and Exports of Nutmegs, 1926–32.
IV. Netherlands: Imports of Nutmegs (for consumption), 1926–32.
V. United States: Imports and Exports of Nutmegs (unground), 1926–32.
VI. Canada: Imports of Nutmegs (including Mace), 1926–32.
VII. London Prices of Grenada and Dutch East Indies Nutmegs, 1920–1933.

MACE

VIII. Grenada, Domestic Exports of Mace, 1921–32.
IX. Dutch East Indies, Exports of Mace, 1921–32.
X. British Malaya, Imports and Exports of Mace, 1926–32.
XI. United States, Imports of Mace (unground), 1926–32.

TABLE I

GRENADA

Domestic Exports of Nutmegs

Year.	Quantity. Long tons.	Value. £	Year.	Quantity. Long tons.	Value. £
1921	901	34,007	1928	981	87,965
1922	1,127	59,957	1929	1,133	100,323
1923	1,081	55,017	1930	999	67,794
1924	968	95,321	1931	1,320	54,808
1925	1,088	145,861	1932	1,365	(not yet available)
1926	1,135	127,000			
1927	1,062	103,444			

TABLE II

DUTCH EAST INDIES

Exports of Nutmegs

	Cultivated.				Wild.			
	Unshelled.		Shelled.		Unshelled.		Shelled.	
	Quantity.	Value	Quantity.	Value	Quantity.	Value.	Quantity.	Value.
	long tons (a)	£	long tons. (a)	£	long tons (a)	£	long tons (a)	£
1921 .	1,822	62,085	914	70,211	3	59	—	—
1922 .	1,286	52,528	1,232	98,045	16	507	11	698
1923 .	1,933	71,901	1,099	87,361	10	318	90	5,434
1924 .	1,726	154,095	1,323	155,221	23	839	119	8,115
1925 .	1,714	158,953	1,405	194,297	45	1,712	290	22,835
1926 .	2,475	190,025	1,001	125,046	53	1,994	269	20,179
1927 .	2,594	177,858	1,479 1,302(b)	187,663	59	2,262	219	16,532
1928 .	2,917	165,168	1,065 943(b)	105,524	76	3,325	239	15,722
1929 .	2,391	124,403	1,478 1,287(b)	108,328	71	2,927	160	9,517
1930 .	2,307	89,369	1,498 1,314(b)	96,592	66	2,241	131	5,742
1931 .	1,905	49,600	2,244 1,977(b)	106,500	75	1,700	127	3,400
1932 .	1,944	46,700	1,735	102,600	Not yet available			

(*a*) *Crude weight* (*b*) *Net weight.*

TABLE III

BRITISH MALAYA

Imports of Nutmegs

Country from which imported.	Long tons.						
	1926.	1927	1928.	1929	1930.	1931.	1932.
Dutch East Indies:							
Celebes and Moluccas .	2,058	2,271	2,107	1,975	1,724	1,540	—
Java . . .	76	35	40	39	88	23	—
Sumatra . .	108	121	128	107	112	99	—
Siam . . .	14	9	15	17	7	8	—
Other countries .	1	—	1	3	—	19	—
Total . .	2,257	2,436	2,291	2,141	1,931	1,689	1,601
Total Value (£) .	173,799	148,997	143,793	113,389	64,967	40,547	39,278

Exports of Nutmegs

Country to which exported.	Long tons						
	1926	1927	1928	1929	1930	1931	1932
United Kingdom	146	265	248	188	155	136	158
British India and Burma	452	357	399	455	424	362	905
Australia	109	104	114	129	89	103	
Hong Kong	111	98	81	46	56	53	
Germany	85	115	93	118	81	79	
Netherlands	102	207	249	147	145	103	
United States	212	322	338	136	105	127	
Other countries	180	202	258	217	212	254	
Total	1,397	1,670	1,780	1,436	1,267	1,217	1,063
Total Value (£)	184,285	181,659	168,285	120,756	72,781	53,652	43,400

TABLE IV

NETHERLANDS

Imports (for consumption) of Nutmegs

Country from which imported	Long tons						
	1926	1927	1928	1929	1930	1931	1932
Total	278 £43,966	324 £40,583	317 £36,357	342 £32,917	362 £23,678	395 £20,800	399 £20,100
Including from Dutch East Indies	245 £38,974	233 £28,427	221 £24,773	245 £23,272	274 £17,305	315 £16,000	376 £18,700

TABLE V

UNITED STATES

General Imports of Nutmegs (unground)

Country from which imported	Long tons						
	1926	1927	1928	1929	1930	1931	1932.
Total	1,653 £218,976	2,042 £232,102	1,893 £174,641	1,866 £158,753	1,747 £111,665	2,031 £92,100	1,910 £85,700
Including from British West Indies	679 £80,248	740 £81,295	622 £58,207	844 £69,700	720 £40,906	877 £32,400	not yet available.
British Malaya	217 £32,161	278 £33,646	335 £31,531	162 £14,428	97 £6,658	138 £7,300	
Java and Madura	240 £25,513	260 £24,944	338 £25,717	311 £21,825	228 £12,887	306 £13,800	
Other Dutch East Indies	196 £26,885	313 £35,184	228 £19,336	314 £29,403	406 £28,859	656 £35,200	
Netherlands	271 £42,211	288 £37,418	268 £30,035	175 £18,742	242 £19,610	40 £2,500	

Re-exports of Nutmegs (unground)

Total	72 £11,646	167 £23,624	97 £12,098	106 £11,607	53 £4,680	32 £2,100	32 £2,300

TABLE VI

Canada

Imports of Nutmegs (including Mace)

Description and country from which imported.	Long tons.						
	1926.	1927.	1928.	1929.	1930.	1931.	1932.
Whole or un-ground.							
Total	126	150	129	138	140	118	111
	£20,209	£19,705	£16,444	£12,864	£10,504	£6,422	£5,073
Including from United Kingdom	16	16	10	3	2	2	3
	£2,009	£1,752	£1,511	£461	£292	£158	£210
United States	7	3	4	4	5	2	2
	£1,770	£653	£522	£651	£579	£241	£213
British West Indies	85	108	81	116	113	91	89
	£13,693	£13,763	£9,273	£10,012	£7,120	£4,257	£3,742
Straits Settlements	not available	14	24	9	18	14	10
		£2,563	£3,984	£1,054	£2,163	£1,020	£591
Ground:							
Total	2	3	4	10 cwt	8 cwt.	3 cwt.	6 cwt.
	£355	£410	£436	£97	£43	£27	£42
Including from United Kingdom	2	2	2	4 cwt.	—	1 cwt.	1 cwt.
	£329	£315	£255	£57	—	£18	£13
United States	4 cwt.	1	1	5 cwt.	8 cwt.	2 cwt.	5 cwt.
	£26	£85	£125	£38	£43	£9	£29

TABLE VII

Grenada and Dutch East Indies Nutmegs

London Wholesale Prices

(From *The Grocer*)

Year.	Grenada	Dutch East Indies.		
		64's–57's.	110's–80's.	160's–120's.
	s. d. s. d.	*s. d. s. d.*	*s. d. s. d.*	*s. d. s. d.*
1933	0 5½–0 6½	1 3	0 8–0 10½	—
1932	0 7–1 4	1 6½	0 10–0 11	—
1931	0 7–1 3	1 3–1 9	0 8–0 10	—
1930	0 11½–1 10	1 9–2 0	1 0–1 5	0 8–0 10½
1929	1 3½–2 2	2 9–3 0	1 5–2 2	1 3–1 5
1928	1 3–2 2	2 9–3 0	1 5–2 2	1 2½–1 4½
1927	1 6–2 6	2 9–3 2	1 10–2 2	1 6–1 8
1926	2 2–2 9	3 0–3 5	2 6–2 9	2 2–2 3
1925	2 2–2 9	2 9–3 3	2 3–2 9	2 1–2 2
1924	1 6–2 0	2 7	2 0–2 3	1 9–1 11
1923	0 5–1 8	1 5–1 9	0 9–1 2	0 7–0 8
1922	0 5–1 7	1 5–1 8	0 9–1 2	0 7–0 8
1921	0 4–1 2	0 11–1 3	0 8–0 9	0 6–0 7½
1920	0 9–2 4	2 0–2 4	1 6–1 10	1 0–1 4

The figures are those for the day nearest to June 24 on which quotations were given in each year.

TABLE VIII

Grenada

Domestic Exports of Mace

Year.	Quantity. Long tons.	Value. £	Year.	Quantity. Long tons.	Value. £
1921	145	12,915	1927	187	59,145
1922	159	17,066	1928	157	49,260
1923	154	18,641	1929	188	55,766
1924	162	24,874	1930	178	41,395
1925	192	39,606	1931	183	28,864
1926	184	49,490	1932	209	(a)

(a) *Information not yet available.*

TABLE IX

Dutch East Indies

Domestic Exports of Mace

	Long tons			Long tons	£
1921	399	39,345	1927	669	175,430
1922	571	64,761	1928	659	149,905
1923	625	71,307	1929	726	172,326
1924	536	124,881	1930	703	142,275
1925	551	156,539	1931	657	79,800
1926	680	192,069	1932	651	64,100

TABLE X

British Malaya

Total Imports of Mace (long tons)

Country from which imported.	1926.	1927.	1928.	1929.	1930.	1931.	1932.
Celebes and Moluccas	174	193	220	166	165	129	—
Sumatra	16	24	38	49	28	31	(a)
Other countries	5	3	6	10	4	2	—
Total	195	220	264	225	197	162	179
Total value (£)	58,738	62,055	68,310	54,503	30,260	15,332	14,909

(a) *Information not yet available.*

Total Exports of Mace (long tons)

Country to which exported.	1926.	1927.	1928.	1929.	1930.	1931.	1932.
United Kingdom . .	9	22	14	2	5	2	—
British India and Burma	77	69	71	77	71	69	
Australia	31	30	35	39	26	31	115
Other British Empire .	10	19	21	14	18	21	
United States . . .	50	77	102	71	55	28	42
Other foreign countries .	6	7	12	7	16	4	7
Total	183	224	255	210	191	155	164
Total value (£) .	61,303	66,943	70,240	53,668	32,018	16,985	15,837

TABLE XI

UNITED STATES

Imports of Mace (Unground)

	Long tons.	£		Long tons.	£
1926 . .	314	85,820	1930 . .	305	70,027
1927 . .	391	121,398	1931 . .	278	41,000
1928 . .	293	90,708	1932 . .	326	44,500
1929 . .	335	97,469			

NOTES

Australian Wool Industry.—The unprecedented fall which has taken place in the price of Australian wool during recent years is largely responsible for the present adversity in the Dominion. The value of the exports of wool has fallen very much more than the value of all other exports in spite of good seasons, the drop between the years 1927–28 and 1931–32 being £34,000,000 per annum in Australian currency.

In the face of these facts it is obvious that the industry cannot continue on its present basis, and in August 1932 the Commonwealth Government appointed a Committee to enquire into the position of the Australian wool industry and to make recommendations with a view to its rehabilitation. The report of this Commonwealth Wool Inquiry Committee has now been published in Australia as a Parliamentary Paper, and the following notes will indicate the nature of its findings.

It is shown that during the last two seasons the average typical cost of producing wool (exclusive of all interest) has been at least ½d. per lb. greater than the average price at the sales in Australia. The interest payments average 1¾d. per lb. of wool. Consideration is given to the various

directions in which reduction in costs could be effected, and recommendations are made regarding rail freights, State Government charges, private business charges, handling and selling charges, interest rates, and land taxes, both Federal and State. The Committee also considered the question of a loan or bounty to growers, but were in favour of neither, and pointed out that the alternatives are the successful control of marketing, giving a higher world price, or an increased rate of exchange on sterling, giving a higher Australian price.

The recent history and present organisation of the wool industry are fully described, and the existing policy of avoiding a carry-over of wool is regarded as substantially sound. The present position is one not only of low prices, but also of instability, and special action may be required to avoid, if possible, any relapse in prices. The Committee therefore consider that machinery for speedy action should be established, and recommend (*a*) that a National Wool Executive be constituted by the Wool Growers' Council, and (*b*) that the Commonwealth Government, by regulation or otherwise, should take to itself power to prohibit the export of wool, except on such conditions as may be prescribed, provided that such power should not be exercised except at the request of the Commonwealth Wool Executive.

In conclusion the Committee devote special attention to the question of national policy and express the opinion that if the present gap between costs and prices can be closed wool will find a firmer foundation and more stable future than for many years past.

Phormium Tenax (New Zealand Hemp) Cultivation in Argentina.—A short account of the position of Phormium cultivation in Argentina, abstracted from Publication No. 877 of the Ministry of Agriculture, Argentine Republic, has been published on pages T78–T80 of the *International Review of Agriculture* (Rome, 1933).

It is stated that Phormium cultivation has recently become of some importance in the Islands of the Parana Delta. The plant was introduced about thirty-five years ago and planted in low-lying ground liable to flooding. In view of the facility with which the plant multiplied and the economic importance of its fibre in New Zealand, certain progressive farmers attempted to encourage its development, but it was not until 1923 that the crop had become of any real importance. At the present time Phormium plantations occupy 1,500 hectares.

In 1918 plant was installed for extracting the fibre, and

excellent results were obtained with respect both to yield and quality, and in 1923 further plant was established at Parana Mini.

The latter factory deals with the production of most of the plantations. Small plantations (one to five hectares) are owned by a number of growers and are distributed throughout the whole region. Some of these growers have combined to form a co-operative society for the establishment of a factory for extraction of the fibre.

Phormium cultivation is said to be extending into other regions of the country, viz. in the west of the province of Buenos Aires, in the low-lying land near the River Uruguay at Tucuman, Misiones and elsewhere.

The following varieties are said to be grown on an industrial scale.

(1) This variety, which is the most commonly grown, is derived from the first plants introduced into the Parana Delta. Its leaves are four metres long, pointed at the ends and of an intense green with a prominent midrib of a darker colour.

(2) The second variety, which is next in order of importance, has been developed from seed imported from New Zealand in 1910. The leaves are smaller and of a paler colour than those of the preceding variety.

(3) This variety is a bronzed form, with wide leaves, three metres in length; it is fairly commonly grown and is of interest on account of its high fibre-content and its capability of withstanding a cold climate.

(4) This variety, which is very common, is a variegated form and has been tried industrially. It has thin, wide leaves with a high content of fibre which is of fine texture and specially valued for certain manufactures.

The plants are set in the plantation at a distance of one metre from each other in rows two metres apart. The whole of the requirements for planting material (seed and suckers) can be obtained from the planters in the Delta.

The first crop is cut when the leaves have reached a length of two metres, that is, from four to six years after planting. The first cutting should amount to 50,000 kilos. of fresh leaves per hectare and will increase steadily by 15,000 kilos. at each successive cutting until a maximum of 100,000 kilos. is reached. The yield of fibre obtainable from the leaves ranges from 5 to 22 per cent. according to the variety.

Sugar-cane Moth Borer (Diatræa) Investigations in the West Indies.—A preliminary report of the work on this subject undertaken by Mr. Harold E. Box in Antigua

during 1931 was published in this BULLETIN (1932, **30**, 185–197). The investigations were continued in 1932 in both Antigua and St. Kitts and an advance copy of Mr. Box's report on the work carried out during the year has been furnished to the Imperial Institute by the Colonial Secretary of the Leeward Islands. The greater part of the report is occupied by a detailed account of the introduction and establishment of the Cuban parasite (*Lixophaga diatrææ*) into the islands, whilst other questions dealt with include (1) *Trichogramma*, the native egg-parasite of *Diatræa saccharalis*, which is shown to be ineffective as a means for controlling sugar-cane moth borers, (2) the extent of moth-borer infestation in Antigua and St. Kitts during 1932, (3) the determination of field losses due to the pest, (4) other host plants of the moth borer (the Guinea Grass, *Panicum maximum*, must be added to the list of Antigua grasses published in the previous report, *loc. cit.*, p. 196, whilst in St. Kitts the Long Grass, *Valota insularis*, was the only wild grass attacked ; in Nevis no plants other than sugar-cane and maize were found attacked), (5) improvements in cane cultivation (certain suggestions put forward in the previous report have been adopted on quite a large scale, and the results have fully justified the change), and (6) experiments with European parasites of the Corn Borer (*Pyrausta nubilalis*) against Diatræa in Antigua.

The section of the report dealing with *Lixophaga* does not lend itself to abstracting and those interested may be referred to the printed report which it is understood will be issued by the Antigua authorities in due course. It may be stated, however, that the results of the first year's work are distinctly promising and on the whole are not dissimilar to those secured in the first year after the Tachinid *Ceromasia* was introduced into the Hawaiian Islands to combat the Sugar-cane Beetle Borer (*Rhabdocnemis obscura*), which was effectively reduced to a state of minor importance within a few years of the introduction of its parasites.

The Damars of the Malay Peninsula.—Under this title a comprehensive report by T. A. Buckley, Forest Chemist, F.M.S., has been issued by the Forest Department of the Federated Malay States (*Malayan Forest Records*, 1932, No. 11). The following notes have been abstracted from the report.

The Malayan word " damar," meaning resin, is applied in Malaya indiscriminately to resins of any botanical origin. Commercially the term refers to the resins derived from

trees of the *Dipterocarpus* family in the East Indies and described as Singapore, Batavia, Padang or Pontianak damar after the names of the places where trade in the commodity is centred. The quantity of East Indian damar actually collected in the Malay Peninsula is not large for various reasons, among which are the following: the indiscriminate and destructive tapping of resin-bearing trees has been discouraged, damar collecting has been more arduous and less lucrative than rubber production, the trees are widely scattered and labour is difficult to find for schemes of exploitation.

The most important Malayan damar is damar penak, derived from *Balanocarpus Heimii* King, one of the most valuable timber trees in the country. Although widely distributed it is unusual for more than one large tree to occur in each two acres of forest. The Forest Department took control of the industry in this damar in 1922 with the result that supplies of the unadulterated resin, guaranteed to be derived from a single botanical species, have been sorted, graded and marketed. A full account of the grades of damar penak has already been published by R. W. Blair and F. E. Byron in *Malayan Forest Records*, 1927, No. 4.

On tapping the tree, the resin exudes in a semi-liquid form, hardening mostly in stalactitic masses, and is collected after about three months. It is subsequently sent to a central station where it is sieved and afterwards graded by hand according to colour and size. Mr. Buckley has examined the possibility of purifying damar dust by the salt vacuum process employed for the cleaning of kauri in New Zealand and found experimentally successful in the case of damar penak by Blair and Byron. Working on a moderately large scale, however, the operation proved so tedious, especially with the fine dust, that it was concluded that the dirt could be removed more economically after solution of the damar than before. Details are given of investigations which Mr. Buckley has carried out with a view to determining the chemical nature of damar penak, such as the separation of components by solvents, properties of the resin-acid and non-acid constituents, the action of heat on the damar, and its behaviour on distillation with sulphur. Damar penak is a good material for making spirit varnishes for interior uses, but there is some prejudice against it owing to the varnish solutions frequently becoming cloudy on standing. The cause of the cloudiness has been investigated and is attributed to aggregation of particles of a resin acid, which are at first colloidally dispersed and invisible. Means of avoiding this defect

are discussed, but these are rather uncertain and are considered unnecessary, as the cloudiness does not detract from the utility of the varnish. As an ingredient of cellulose lacquers, damar penak is less popular than Batavian damar because it contains a higher proportion of a substance insoluble in lacquer solvents. The author points out that this insoluble portion, owing to its high melting point, freedom from colour, and solubility in hydrocarbons, might well be employed for other purposes.

The physical and chemical properties of damar mata kuching obtained from different species of *Hopea*, and damar temak from *Shorea hypochra* Hance—the two other pale-coloured Malayan damars of economic value—have been similarly examined. These two resins are hardly distinguishable from one another, and closely resemble damar penak. They possess rather lower acid and saponification values than damar penak, and also have rather lower melting points. All three resins, however, are of similar composition, and are not liable to deterioration by weathering. Although not so hard as damar penak, damars mata kuching and temak cause less trouble in hydrocarbon varnishes, and contain a smaller proportion of constituents insoluble in lacquer solvents. Damar mata kuching is not a resin that could be produced in regular supply, for the trees do not respond consistently to tapping. Damar temak has been produced experimentally on a commercial scale. Recently it has been preferred to damar penak, and there are hopes of getting increased and regular supplies from the Langkawi Islands in the State of Kedah.

A large number of other Malayan damars have been examined, most of which are at present of little or no commercial value, and are generally dark in colour. These darker-coloured Dipterocarp resins all have higher melting points, and in many cases are subject to weathering. Botanical relationship does not necessarily involve similarity of resin. *Balanocarpus maximus* King and *B. penangianus* King produce dark resins strikingly dissimilar from damar penak. *Shorea acuminata* Dyer, *S. leprosula* Miq., *S. Curtisii*, *S. Ridleyana* King, *S. macroptera* Dyer, *S. parvifolia* Dyer and *S. resina negra* Foxw., produce resins quite unlike the damar temak from *S. hypochra*. Two species of *Shorea*, however—*S. gratissima* Dyer and *S. bracteolata* Dyer—produce pale resins similar to damar temak. Another species of Shorea, *S. lævis* Ridl., yields a pale resin, melting at 170°–190° C. or about twice as high a temperature as damar penak, but this is liable to deterioration. Damar chengal pasir, derived from an undetermined species of *Hopea*, is a pale resin of the same type as

damar mata kuching, but its melting point is appreciably higher.

Dryobalanops aromatica Gaertn., the Borneo camphor tree, is an abundant and gregarious species mainly restricted to the east side of the Malay Peninsula. It furnishes a pale-coloured oleo-resin yielding 20 per cent. of volatile oil, composed principally of sesquiterpenes. The resin is not plentiful and is not collected. With one exception it was the most widely soluble damar examined, and an alcoholic solution gave a pale lustrous varnish coat which was not easily scratched.

Damar kedondong is the local name for several species of *Canarium* mostly yielding soft resins, which are of the elemi type but could not compete with Manila elemi derived from *C. Luzonicum*. A sample of *C. rufum* Benn. yielded about 13 per cent. by weight of essential oil. The residual resin melted at 70°–80° C. and unlike Manila elemi could not be induced to crystallise from methyl alcohol. Damar sengai, said to be derived from *C. hirsutum* Willd., yields one of the hardest Malayan resins. It forms large dark-brown stalactitic masses. A sample of this resin examined by the author melted at 120°–135° C. and was almost devoid of acidity. Although sparingly soluble in alcohol it dissolves completely in petroleum ether, turpentine and benzene. A turpentine varnish coat, though somewhat deficient in lustre, dried rapidly and became exceedingly hard and tough, and it was scarcely perceptibly coloured in spite of the dark colour of the lump resin.

Several species of *Dipterocarpus*, chiefly *D. Kerrii*, *D. cornutus* and *D. crinitus*, furnish a liquid oleo-resin known as minyak keruong. An examination of a sample of the material some years ago showed that it was similar to Gurjun balsam. It is used locally for medicine and for caulking boats, and there has been also a small European demand. Minyak sepetir, a product of similar character, but derived from species of *Sindora*, is also described.

Damar minyak, an oleo-resin derived from *Agathis alba*, the source of Manila copal, was also investigated. Whereas in the Philippines the exudation requires two or three weeks to harden on the tree, in Malaya this resin does not usually harden. Samples of damar minyak examined yielded from 14 to 18 per cent. of volatile oil consisting apparently chiefly of α- and β-pinene, limonene, dipentene and the sesquiterpene cadinene. The effect of destructive distillation of the resin was studied, and means of producing from it a hard resin were investigated. The author's work confirms that of previous investigators, in

showing that the refusal of damar minyak to harden is due to the presence of slowly volatile hydrocarbons.

The Sutlej Deodar.--In the *Indian Forest Records* (*Sylviculture Series*), Vol. XVII, Part IV, 1933, Dr. R. Maclagan Gorrie deals with the ecology and timber production of the deodar (*Cedrus Deodara* London), one of the characteristic coniferous trees of India and the most valuable timber species in the North-west Himalaya. The Sutlej river, flowing from western Tibet to the Punjab plains, has cut a stupendous gorge through the granite core of the Himalayas and for some eighty miles is the principal geographical feature of Upper Basharh Forest Division. The great Sutlej Valley carries forests which constitute one of the main sources of supply of deodar timber for the markets of Northern India. The forests form a belt along both sides of the valley from the outer hills of the Lesser Himalaya to the Tibetan border, and are remarkable for their occurrence under climatic conditions varying from the wet heavy monsoon of the outer hills to the dry arid country beyond the main range of the Himalaya where the precipitation consists almost entirely of winter snowfall. The plants associated with the deodar naturally vary greatly between these two extremes, and the object of Dr. Gorrie's paper is to trace the relationship between the plant associates of the tree and its value as a timber-yielding species. In pursuance of this aim the author, after introductory chapters on topography, geology, climate and other ecological factors, distinguishes the forest types of Kanawar as falling into three main divisions, viz. a *moist zone* in the lower valley where deodar occurs on the drier and warmer ridges, generally scattered among other tree species; a *dry zone* in middle Kanawar where the deodar reaches its optimum development and forms large areas of pure forest; and an *arid zone* in the further parts adjoining the Tibetan border where the trees develop well only on cool aspects and at higher elevations than elsewhere. The botanical formations of these forest zones have been carefully studied and detailed vegetation lists comprising trees, shrubs and herbs, compiled. The lists are followed by a long chapter affording an analysis of the ecological factors of the common plants of the forest types, arranged by natural orders, and containing evidence of much detailed observation.

As the outcome of his work the author has ascertained that the habit of growth of the deodar alters entirely between the two extreme conditions of its occurrence as described above. In the outer hills the tree

keeps to the best drained spurs and ridges, while in the inner hills it seeks the gentler slopes which retain their snow beds longest into the spring. The accompanying plant associates similarly alter completely between the extremes except for the blue pine which accompanies the deodar throughout. The capacity of the deodar as a timber producer varies greatly with climatic differences and the variations have been correlated by the author with changes in its plant associates. In the case of existing stands the deodar itself is the best indication of the quality class of the forest, and the author proposes to employ vegetation lists only in the determination of the site quality class where the existing crop is an abnormal one. The plants indicating optimum conditions for deodar in the moist zone (showing deodar in mixed crops with spruce and blue pine) comprise the maidenhair ferns (*Adiantum Capillus-Veneris* and *A. venustum*), the strawberry (*Fragaria vesca*), stinging nettle (*Urtica dioica*), *Primula denticulata*, *Ainslia aptera*, *Arundinaria falcata*, *Smilax* spp., *Viola* spp. and *Wulfenia amherstiana*; while the corresponding indicators in the dry and arid zones (with deodar in pure crops) are deadly nightshade (*Atropa Belladonna*), strawberry, *Artemisia vestita*, *Asparagus gracilis*, *Astragalus chlorostachys*, *Bupleurum* spp., *Desmodium tiliæfolium*, *Indigofera gerardiana*, *Polygonatum* spp., *Polygonum* spp., *Thalictrum* spp. and *Viola* spp.

The research will no doubt be of much value in assisting an understanding of Himalayan sylviculture of the tree species concerned.

Soil Surveys.—The work of Shantz and Marbut on the *Vegetation and Soils of Africa* admittedly gave only the roughest outline of the distribution of the main soil types, and many of their suggestions were based on analogy and inference rather than on detailed knowledge. During recent years, however, a considerable amount of work on the characterisation and distribution of the chief types of soil has been going on in both the East and the West groups of African Colonies. A start has now been made with the publication of some of this information by the appearance of the *Soil Survey of Sierra Leone*, by F. J. Martin and H. C. Doyne (Department of Agriculture, Freetown, Sierra Leone, 1932).

Sierra Leone readily lends itself to a soil survey of the extensive kind, as the number of types of soil is small and their distribution is of a simple character.

The climate is tropical and the rainfall high--from 90 to 150 inches per annum, practically all the rain falling

during the wet season, from April to November. The system of agriculture followed by the natives is that of "shifting cultivation," rice being the staple crop. Usually only one crop of rice on a site is grown, a fresh "farm" being selected for the following season, although in parts of the Northern Province the land is cultivated for two years, fundi or ground-nuts being grown during the second year.

Since the soils of Sierra Leone have been subjected to conditions of high temperature and high rainfall, they have been strongly leached and the great majority of them fall within the classes defined by the authors as laterite or lateritic. These definitions are based on the molecular ratio of silica to alumina present in the clay fraction of the soil, the clay being regarded as the most characteristic portion. When this ratio falls below 1·33, the soil is called a laterite, while if the ratio is above 1·33, but under 2·0, the soil is described as lateritic. Practically all the soils of Sierra Leone which have been examined are included in one or other of these two groups. The characterisation of the different soil types is based chiefly on colour, the mechanical composition and the composition of the clay fraction. Most of the soils were examined to a depth of 4 feet.

The main soil types distinguished by the authors are as follows:—Laterite and Lateritic Gravel, which are by far the most widely distributed and are indistinguishable by eye; Red Sandy Soils, of limited extent; Brown Lateritic Sand and Sandy Loam, occurring in areas near the coast and in valleys inland; Coarse Sandy Soils, on the extreme littoral belt of the Southern Province; Black Swamp Soils, around estuaries, and inland wherever the configuration of the ground allows and drainage is impeded; and Black or Brown Grit Soils, in extreme parts of the Northern Province.

All the soils described are more or less acid in reaction and their contents of phosphoric acid, potash and exchangeable lime are low. Owing to native methods of cultivation, the amounts of organic matter and of nitrogen vary widely according to the length of time which has elapsed since the soil was last cultivated.

A large number of mechanical analyses of soils, grouped geographically, are given in an Appendix and a Provisional Geological Map and a map showing the distribution of the soil types described are also included.

Imperial Institute Publications on Mineral Resources.—*Lead.*—The latest addition to the Imperial Institute series of publications on the Mineral Industry of the British Empire and Foreign Countries is a revision of the brochure

on *Lead*, issued by H.M. Stationery Office, in May last, price 4*s*. (by post 4*s*. 4*d*.).

The British Empire supplies 26 per cent. of the world's production of lead, and three Empire countries are amongst the leading producers, Australia being third, Canada fourth and Burma seventh.

Since the issue of the first edition of this volume, important new deposits of the metal have been located and its uses still further extended; consequently the document, which has been entirely rewritten, has grown from 95 to 253 pp.

The bulk of the book (183 pp.) consists of a summary of information concerning the occurrence, geology and mining of lead ores; and no country, British or foreign, in which occur lead deposits of present or potential economic interest is neglected. An interesting feature is a list of principal mines, smelters and refiners in the British Empire, which will be useful for reference.

There is also given an account of the concentration and metallurgy of lead ores, and the numerous industrial uses for the metal, its alloys and compounds.

The metallurgy of the base metals has been revolutionised by the development of concentration by flotation, and this process, as applied to lead ores at Broken Hill, N.S.W., is fully described. The section devoted to the metallurgy of lead includes an account of the latest improvements in the refinery at Port Pirie, South Australia. This plant is unique in that the process is continuous, a steady stream of metal continuing through all stages until the market lead flows into the mould of the casting wheel. The composition of this metal, together with that of a number of commercial leads, is shown in an interesting table which also gives the requirements of some standard specifications for lead in use in Great Britain and the United States.

The section devoted to uses (17 pp.) briefly describes modern development in regard to lead alloys and pigments, and tables are given summarising the composition of lead-base bearing alloys, type metals or printers' alloys, soft solders, fusible alloys, bronzes and regulus metal. Methods for the manufacture of lead pigments are also briefly described.

Another useful feature of the volume is the inclusion of statistics showing the trade in lead and its compounds during recent years in the chief lead producing or consuming countries.

The extent to which the literature of lead has been combed in the preparation of the Imperial Institute's publication is indicated by the bibliography, which runs to no less than 26 pp.

RECENT RESEARCH ON EMPIRE PRODUCTS

A Record of Work conducted by Government Technical Departments Overseas

AGRICULTURE

Soils

Ceylon.—The following account of soil erosion investigations is taken from Dr. A. W. R. Joachim's Report on the Work of the Chemical Division, Department of Agriculture, for 1932.

In addition to the routine determinations of dry matter in liquid and solid samples from the pits in the soil erosion experiment at the Experiment Station, Peradeniya, soil samples from the plots and concrete pits were analysed in order to study the losses of fertilising constituents through erosion from the various plots since 1928, when the samples were last taken. The *Indigofera* plots show percentage increases in nitrogen and organic matter but the controls show decreases. The smallest losses of clay occur from the *Indigofera* plots and the largest from the controls. The eroded soil material is generally richer in fertilising constituents than the parent material from which it is derived. On the average about 71 lb. of nitrogen, 67 lb. of potash and 27 lb. of phosphoric acid are annually lost from an acre of this soil through erosion. The analytical data furnish additional evidence of the value and relative efficiencies of a cover of *Indigofera endecaphylla* and a contour hedge of *Clitoria cajanifolia* in checking soil erosion and the loss of soil fertility.

Further reference to this work is contained in Mr. W. C. Lester-Smith's Report on the Work of the School Farm and Experiment Station, Peradeniya, for the year 1932. It is there stated that the final year's figures of losses of soil from Area A of the soil erosion experiment commenced on June 1, 1926, are now available. The figures for 1931–32 are as under:

Year.	Control plots lb	Indigofera plots. lb.	Clitoria plots. lb.
1931–32	432·4 (100)	127·5 (29·4)	236·6 (54·7)

The totals for the 6-year period 1926–32 are:

Year.	lb.	lb.	lb.
1926–32	6531·3 (100)	3650·6 (55·8)	5919·3 (90·6)

The calculated losses of soil in tons per acre for the whole period (6 years) are as follows:

Year	Control plots	Indigofera plots.	Clitoria plots.
	tons	*tons*	*tons.*
1926–32	101·8	56·7	92·4

The average loss of soil in inches per annum is:

tons.	*tons.*	*tons.*
0·135	0·075	0·123

From the figures available it has been calculated that one inch of top soil would be lost from the control plot in 7½ years, from the *Clitoria cajanifolia* plots in 8¼ years and from the *Indigofera endecaphylla* plots in 20 years.

The results indicate that both the planting of a ground cover crop of *Indigofera endecaphylla* and the establishment of contour hedges of *Clitoria cajanifolia* assist very appreciably in reducing the amount of soil erosion under the conditions of the experiment, though neither of them prevents it entirely.

The slope of the plots is what might be termed very steep from casual observation; actual measurement shewed the gradient to vary between 20° and 30°.

Complete details of the full experiment have been incorporated in an article compiled jointly by Mr. T. H. Holland (who, until his recent retirement, was in charge of the Experiment Station, Peradeniya), and the Agricultural Chemist (Dr. A. W. R. Joachim), which has been published in the *Tropical Agriculturist* (Vol. lxxx, No. 4, 1933, pp. 199–207).

Cover Crops

Uganda.—The following account of work on cover crops conducted at the Serere Experiment Station is contained in the report for the half-year ending December 1932, furnished by Mr. P. Chandler, Plantation Manager, and is supplementary to the report published in this Bulletin (1932, **30,** 321).

1. *Stizolobium deeringianum.*—This has already been mentioned in a previous report as being a new introduction in 1932. Received in May, sowing took place during the first week in June at a spacing of 3 ft. each way. Good germination resulted and a wonderfully quick growth, both in length and depth, was produced.

Towards the end of the year the majority of this mass of growth had fallen, became decomposed to a large extent and produced an excellent mulch held by numerous twining stems. Incidentally, this deciduous habit of the plant had

rather a good effect, as it simplified the collecting of seed immensely, which being borne in clusters on the soil surface would otherwise have been hidden.

The harvesting of seed began on December 31, and was therefore incomplete at the date of writing the report. Up to that time 604 lb. of seed had been collected from an area of half an acre.

An interesting point which came to notice whilst carrying out harvesting, was that the densely packed hairs on the fruits are capable of setting up an irritation of the skin. The pickers, however, did not complain of their fingers in this respect, but stated that the effect was felt on less exposed parts of the body, the neck, for instance, when wiping off perspiration.

Judging by this first year's performance, and taking into consideration that the plant has proved very resistant to both pests and diseases, there is every reason to believe that it will form a valuable addition to the green manure crops of the district.

2. *Phaseolus calcaratus*.—Reintroduced and sown at the same time as the above, and at a similar spacing distance, it has again proved to be less useful.

Growth eventually was both good and dense, but very slow at the start. It is of a softer nature and does not stand up to storms at all well, much less so when hail storms are experienced. Hail in September nearly killed the plants. Dry spells are also unfavourable, many plants dying off in November.

Another thing observed has been its susceptibility to attacks of certain flower-bud eating beetles, mainly those commonly found on *Dolichos Lablab*. These so completely ate all the early crop of flowers that no immature fruits were to be seen at the close of the year.

3. *Dolichos Lablab*.—Harvesting of seed commenced in December from plots sown during June, spacing distance 2 × 1½ ft., but was incomplete at the time of writing the report, roughly 740 lb. of seed having been secured from 1¾ acres at the close of the year.

The final yield is anticipated to be well below average on account of repeated daily attacks by beetles in the early flowering stage when large numbers of buds are eaten. It is estimated that almost 50 per cent. must have been destroyed in this manner. The particular insects doing this damage were *Mylabris bifasciata* and *Coryna apicornis*. At one time hand collecting of the former was tried, but so numerous did they become, and so little impression was made, that this practice was abandoned on grounds of economy.

A certain amount of disease (possibly *Elsinoe canavaliae* Roc.) was present when the plants were well advanced, but on a very much smaller scale than last year.

4. *Canavalia ensiformis.*—At the close of the year seed was being collected from plots sown in June and July. One area of 1¾ acres, spacing 2 ft × 1 ft. 6 in., had up to then yielded 831 lb. Several pods of exceptional size were noticed, containing up to fifteen seeds.

There was promise of a good yield all round, well above average, in spite of white ants eating off several plants over a part of another area when they were almost at the flowering stage.

5. *Soy Beans* (*Glycine hispida*).—The excellent yield anticipated at the time of writing the previous report was fulfilled, the total being at the rate of rather more than 1,000 lb. per acre. Actually 251 lb. were taken off the one quarter-acre plot.

A later sowing harvested during October did not do nearly so well, producing 286 lb. only from half an acre.

6. *Sunn Hemp* (*Crotalaria juncea*).—One ten-acre block was put under this crop for green manurial purposes during September after harvesting ground-nuts. Sown with the seed barrow, the seed rate was equal to 65–70 lb. per acre.

An excellent stand resulted, but the subsequent growth was far less vigorous and more dwarf than that of the spring sowings.

Rather a heavier seed rate would have been more beneficial under the circumstances, although quite a useful amount of green material was returned to the soil from the several headings back which were made when the plants showed signs of flowering.

7. *Crotalaria striata.*—For green manurial purposes two one-acre plots, blocks D and E, were sown. Slow in getting away at first, a good cover eventually resulted from sowing 20 lb. of seed per acre. Heading appears necessary when the plants have reached 10–12 in. in height to encourage branching, and a similar operation is required later from time to time to suppress flowering and get the optimum amount of green material.

A stock plot planted during May came into flower a few weeks before the close of the year, and by December 31 had seed here and there almost ready for harvesting. The plants were about 4½ ft. in height.

8. *Crotalaria alata.*—This has been abandoned at Serere owing to its unsuitability, it being too slow growing in the first instance, and eventually sufficient growth is not produced to suppress weeds in any moderate quantity.

INSECT PESTS

Termites

Ceylon.—The following account of termites in Ceylon is taken from the report by Dr. J. C. Hutson on the work carried out during 1932 by the Entomological Division of the Department of Agriculture.

(1) *Termites affecting Plants of Economic Importance*

(*a*) *New Host Plants.*—*Neotermes militaris*, which usually occurs as a pest of tea, has been found during the year in two new host plants which are commonly interplanted with tea in some districts. These were *Crotalaria anagyroides*, a green manure plant which has increased in favour during recent years, and *Cedrela Toona*, a shade and fuel tree. Both records come from the Maskeliya district where this pest is more in evidence than elsewhere in the Island, and the complaints of injury to *Cedrela Toona* were received from two separate estates. *Casuarina equisetifolia* is another new addition to the already extensive list of host plants of *Neotermes greeni*. This record is surprising in view of the exceptionally hard nature of the timber of this tree. The record is of importance as this tree is commonly grown along estate roadsides in certain districts. *Coptotermes ceylonicus*, one of the most destructive of local termites, was responsible for the complete destruction of young plants of the Tung oil tree (*Aleurites Fordii*), and a species of the same termite genus caused injury to *Grevillea robusta*, both of these new records coming from the Galle districts. A species of *Leucotermes* was associated with injury to tea in the Matale district but it is not certain that the injury caused was entirely attributable to the work of these termites. Hitherto, *Leucotermes* has only been found attacking dead wood in Ceylon and has not before been found feeding on the wood of tea bushes.

(*b*) *New Locality Records.*—*Glyptotermes dilatatus* was found attacking tea in the Baddegama district of the Southern Province for the first time. This species is, however, well established in other districts of this province and causes considerable damage to tea. *Neotermes militaris* has not been found in any new districts of the Island during the year, but two new infestations of estates in the Dimbula and Maskeliya districts, respectively, were discovered. Both infestations were obviously of long standing and the estates concerned are surrounded by others where this pest has been established for many years. The location of the known infestations in the Dimbula district suggests a far wider prevalence of the pest in this

district than has hitherto been considered to be the case. *Neotermes greeni* occurred in tea in the Kalutara district for the first time on record and in the same host on two new estates in the Badulla district.

(*c*) *Bionomics.*—This branch of the termite investigation has been continued by Mr. M. P. D. Pinto. The two colonies of *Neotermes militaris* referred to in last year's report are still in a flourishing condition. These have been raised from eggs laid by winged adults nearly six years ago and rudimentary wing pads have now made their appearance in the most advanced members of the colony. The object of these experiments is to ascertain the duration of the life cycle from egg to winged reproductive adult, and when the investigation commenced it was anticipated that this period would not exceed two years. If these colonies can be maintained alive it is probable that the final winged stage will not be reached for another year or more.

The colony of *Glyptotermes dilatatus* referred to in the report for last year as showing no indication of developing to the winged stage has continued to thrive and winged forms have been produced during the year. This colony was raised from eggs laid nearly five years ago by a neoteinic pair. In this experiment six fully grown larvæ were isolated on January 19, 1928. The first neoteinic appeared on March 7, and the second on March 15, these being a pair. The first egg appeared on March 28 after which date egg production was steadily maintained. On May 31, 1928, one of the larvæ developed into a soldier and a fourth larva into a neoteinic on October 16. The remaining two larvæ had undergone no further development up to the time when the most advanced members of the young colony had attained the same size as themselves and, since that time, it has not been possible to differentiate between them. On September 29, 1932, twelve winged adults appeared, the development to this stage from the egg having occupied four and a half years. It is possible that two of these adults had developed from the two original isolated larvæ mentioned above. If so, their final development coincided with that of the younger members of the colony. The original founders of this colony are still alive and active and so, also, is the third neoteinic which appeared in October 1928.

The opinion held by certain investigators that winged termites could not be produced by wingless neoteinic forms is not, therefore, justified. This is the second occasion upon which the above-mentioned result has been obtained in this laboratory, the previous one being the

production of winged adults in two years and seven months from eggs laid by a neoteinic pair of a species of *Planocryptotermes*. This case was mentioned in the report for last year. The production of neoteinic forms from eggs laid by the winged stages is, of course, of frequent occurrence in nature.

The task of maintaining these colonies of termites alive over such an extended period has required daily care and attention and Mr. Pinto is deserving of great credit for the results obtained and for the accuracy of his observations.

(*d*) *Control.*—The Paris Green treatment of tea bushes infested by *Neotermes militaris* continues to give completely satisfactory results. Difficulty in treatment is experienced in certain instances owing to old bushes having lost their original main stem. In these cases numbers of branches have arisen at, or below, the soil level from around the base of the original stem and there is, in consequence, some doubt in the mind of the operator as to where the injection is to be made. As the infestation may be limited to only one or two of such branches there appears to be no alternative but to sound all branches and treat those which are infested. A further complication is that, on occasions, an infested bush may contain two or more separate colonies which do not communicate with one another and in such instances a single injection is insufficient. No remedy can be suggested for overcoming such contingencies, but often the bushes attacked to this degree are so seriously damaged that they are hardly worth preserving and the space they occupy is best utilised by replacing them with supply plants.

During the year the superintendents of sixty infested tea estates on which this treatment has been adopted were circularised in order to ascertain the position in regard to this treatment. The replies received indicated that the treatment was entirely satisfactory when properly applied. In no instance was injury to the bushes reported and in several instances there was stated to be a definite improvement in the appearance of treated fields. Records are now available regarding the treatment of 1,069,611 bushes. As no records of the number of treated bushes have been kept by the superintendents of some estates the actual number of bushes treated is far in excess of the above figure. The average amount of Paris Green required to treat 1,000 bushes is 3½ lb. and the average number of bushes which can be treated daily by one labourer is 60.

The tests with barium silicofluoride referred to in last year's report, and which were continued during the present year, have not been successful. The superior advantages

claimed for this preparation, in comparison with Paris Green, have not been demonstrated in practice and the trials have been discontinued.

The Paris Green treatment of *Neotermes militaris* has now been in operation on estates for a period of nearly five years and has, therefore, been subjected to a reliable trial, and the results obtained certainly justify a continuation of the treatment. Apart from the saving of a large number of bushes which would otherwise have been destroyed by these termites, the emergence of countless numbers of winged reproductive insects has been prevented, with the result that a definite check to the dissemination of the insect, both on infested estates and in the districts in which they are situated, has been achieved. A continuation of the treatment, coupled with the elimination of the dead wood utilised by the winged stages to gain admittance to the bushes, should, in time, bring this very serious pest under a definite measure of control in the tea districts in which it has gained so secure a foothold and become so widely distributed.

(2) *Termites affecting Buildings and Building Materials*

(*a*) *Species concerned.*—Attention to enquiries regarding injury to estate factories, bungalows and other buildings by termites continues to form an important part of the work of the Division, and more than half of the total termite specimens received during the year were in connection with damage caused by these insects to buildings.

The majority of the specimens belonged to the genera *Cryptotermes* and *Planocryptotermes* which are responsible for causing the condition of timber locally termed "dry-rot."

Coptotermes ceylonicus again figured prominently among the specimens of termites affecting buildings, and several instances of extensive damage to the woodwork of estate factories by this species have come under notice. The location of the points of entry to the buildings from the soil and the measures recommended to terminate the further activity of the insects have proved satisfactory in all cases. The same species has also caused damage to the woodwork of several bungalows. Other species found to cause injury to buildings during the year were *Termes horni* and *Eutermes ceylonicus*.

Species of *Cryptotermes* and *Coptotermes* were found to occur in the Batticaloa district during the year for the first time, and in each case caused damage to the timber of buildings.

(*b*) *Bionomics.*—The breeding in captivity of dry-wood termites of the genera *Cryptotermes* and *Planocryptotermes* has been continued by Mr. Pinto. Five colonies of a species of *Planocryptotermes* are still under observation after a period of four and a half years, three of these being raised from eggs laid by neoteinic pairs and two from eggs laid by winged pairs. Wing pads have been formed in the case of the most advanced members of one colony produced by a winged pair.

A colony produced by the mating of a winged male with a neoteinic female of a species of *Cryptotermes* is in a flourishing condition after three and a half years, but there is no evidence of the development of wing pads among the members of this colony. Two other colonies produced from eggs laid by winged pairs of the same species are now three and a half years old and are in a thriving condition.

(*c*) *Tests of Building Materials.*—A few samples of timbers, insulating fabrics and wood preservatives have been under test during the year, chiefly on behalf of the Public Works Department. The insulating materials and wood preservatives are proprietary articles and the details of the tests will not be referred to in the present report.

The tests with two Burmese timbers *Xylia dolabriformis* and *Hopea odorata*, referred to in the report for last year, were continued during the year under review. The tests with *Xylia dolabriformis* have been in progress for a period of two and a half years, ten separate experiments having been conducted. The samples were exposed to the attack of four common subterranean species of termites, *Termes horni, Hypotermes obscuriceps, Cyclotermes redemanni* and *Coptotermes ceylonicus* and one dry-wood-nesting species of the genus *Planocryptotermes*. In no instance was any damage caused to the samples and it is concluded that the claims made in Burma regarding the termite-resistant properties of this timber can be endorsed in Ceylon. The tests have now been discontinued.

Tests with *Hopea odorata* were made against the same species of termites mentioned above with the exception of *Coptotermes ceylonicus* and have been continued for a period of twenty months, no injury being caused to any of the samples during this period. The tests of this timber against *Cyclotermes redemanni* are still in progress, but the others have now been discontinued.

The above timbers appear to be eminently suitable for use in buildings situated in the regions of the Island where termites are troublesome.

(3) *The Destruction of Nests of Subterranean Termites*

The petrol treatment for the destruction of the colonies of soil-nesting termites has been given a very extended trial during the year on Experiment Stations, Gardens and other lands belonging to the Department of Agriculture in various parts of the Island. A very large number of nests on the links of the Kandy Golf Club have also been treated by this method. Considerably over 1,000 nests have been treated in the Royal Botanic Gardens at Peradeniya alone and it can now be claimed that, when properly applied, the treatment is entirely successful.

The destruction of subterranean termites is desirable for several reasons. Most of the commonest local species are serious pests of building woodwork, and consequently all nests in the vicinity of buildings, to which these insects may have access, should be eliminated. The large mounds formed by *Cyclotermes redemanni* and *Hypotermes obscuriceps* are not only unsightly in certain situations, but they interfere with cultural operations on arable land. Further, extensive damage is often caused to the bunds of irrigation tanks by these insects and unless checked might result in considerable leakage, or even breaches, in the bunds.

Unfortunately, it is not always possible to locate the nests of all subterranean termites owing to the excavations of certain species being carried on entirely beneath the surface of the soil without external evidence of their presence. In the case of the two commonest species, which have been mentioned above, the mounds formed immediately above the nests indicate their situations, and consequently treatment presents no difficulties.

The mounds should first be levelled and the entire surface which the mound previously occupied treated by the injection of petrol at suitable intervals. As a result of the large number of nests which have been successfully treated, a convenient formula has been arrived at from which the number of holes to be drilled, and the quantity of petrol to be injected, can be readily calculated. The diameter of the base of the mound should first be ascertained and, when the mound has been levelled, one hole should be drilled in the area previously covered by the mound for every six inches of diameter measurement, one ounce of petrol being injected into each hole so drilled. Thus, the area covered by a small mound, 18 in. in diameter, would require 3 holes and 3 oz. of petrol, while the area occupied by a large mound of 6 ft. diameter would require 12 holes and 12 oz. of petrol. The holes should be

distributed as evenly as possible over the area to be treated and should be about 12 in. deep. The cheapest method of application is to drill the holes with a crowbar and pour in the petrol through a funnel fitted with a long neck. Where funds permit, the Vermorel " Excelsior " Injector can be used with advantage as the dosage can be automatically regulated and the holes drilled by this instrument are inconspicuous. The injector is especially suitable for lawns, golf greens and similar situations where a minimum of disturbance of the surface of the soil is desirable. The treatment has the advantage of being practical and economical.

Beverages

Cocoa

Gold Coast.—In his report for the period July to December 1932, the Director of Agriculture states that cultivation and manurial trials with cocoa were continued and data collected regarding the performance of individual trees, plots and areas, some of which are receiving special attention or treatment. The investigations into production of fruit by the cocoa tree, involving daily records of flowering, flower shedding, fruit-setting, fruit-development and loss, together with data relative to environmental conditions, have been continued, and it is anticipated that this material will assist in elucidating the problem of securing higher yields per tree.

Areas in which the progeny of trees of outstanding merit were established have made satisfactory progress, and selection from parent trees of known performance has been continued.

Special fermentation tests of cocoa beans have been carried out in conjunction with investigations connected with storage trials. These latter were aimed at ascertaining the incidence of mould, weevil and other defects found in the cured product, and their relation to moisture content at different periods, during storage under varying conditions of relative humidity in different parts of the country and at coast ports.

Cocoa Producers' Co-operative Societies.—Producers have been further assisted with the scheme for organising groups able to market their beans in parcels of five tons or more. During the past half-year considerable progress was made with the accumulation of capital and increased membership of established societies. General expansion of the movement led to many new societies being formed and to record progress being made during the year.

Progress of Cocoa Producers' Co-operative Movement, 1932

Details.		As at January 1, 1932.	As at January 1, 1933.
Number of Societies		247	380
Number of Members		4,473	7,625
Share Capital Subscribed		£2,493	£4,709
Cocoa Sales	*tons*	1,081	2,584
Cocoa in Stock	*tons*	409	389

The average purity of the 2,584 tons sold by societies was 98·3 per cent., whereas exports of non-co-operative cocoa shipped during the current major crop period amounted to 84,745 tons, of which the average purity was 92·1 per cent.

Tea

Ceylon.—According to Mr. W. C. Lester-Smith's Report on the Work of the School Farm and Experiment Station, Peradeniya, for the year 1932, a pruning experiment in collaboration with the Tea Research Institute was started during the year. Three methods of pruning are being compared, viz., clean pruning, rim-lung pruning, and cut-across pruning. Each type is being carried out in six plots, each plot comprising 250 bushes. The pruning of these plots was done early in May. The week following pruning, a manurial mixture consisting of blood meal, superphosphate, and muriate of potash was forked in by envelope forking, at the rate of 56 lb. per plot, together with all "dadap" and *Gliricidia* loppings.

The tipping of the pruning experiment plots was carried out during July–August and by the end of August all plots were under regular weekly plucking. Only one bush died after pruning in these plots.

The pruning of the remainder of the tea area was started in the last week of March and was completed at the end of May. The type of pruning employed was a modified rim-lung pruning, that is, all side branches below pruning level were left untouched but none left above the pruning level. It had always been found, in the past, that a certain proportion of those "lungs" which were left die-back at a later stage, and this year all these unpruned branches were, after tipping, cut back to where the first new shoot appeared. In June, Tea Field No. 1, except for the pruning experiment plots, was manured with 300 lb. of "Nicifos" per acre forked in by envelope forking with shade tree loppings to alternate rows. In Tea Field No. 2, except for the pruning experiment plots, loppings were similarly forked into alternate rows but no manure was applied. The manurial application had the effect of almost killing the ground cover of *Indigofera endecaphylla* in the rows

in which the manure was applied, but as the ground was full of its seed a fresh cover from self-sown seed quickly appeared. Tea Field No. 1 was allowed to rest from December 1, 1931, to April 1932, in which latter month it was pruned, and a considerable improvement is noted as a result of allowing the bushes to run-up. All this tea was in plucking again by the middle of August.

The general health of the tea is excellent and the advantage of (1) lighter pruning, and (2) changing the pruning season from October to April is evidenced in the reduced number of casualties after pruning. A weekly plucking round of all the tea has been reverted to in order to conform with the procedure adopted in the pruning experiment plots.

The yields of green leaf for 1932 were as follows:

	Acreage.	No of months in plucking	Total yield of green leaf.	Yield of green leaf.
			lb	per acre. lb.
Tea Field No. 1 . .	12½	6	17,877	1,430
Tea Field No 2 . .	8	11	12,219	1,527

The total quantity of made tea for the year from the whole area was 6,784 lb., a yield of nearly 331 lb. of made tea per acre.

The report of Mr. F. P. Jepson, Controller of Plant Pests, on the work carried out by the Division of Plant Pests, during 1932, contains the following references to pests of tea in Ceylon:

Shot-hole Borer (*Xyleborus fornicatus*).—In order to prevent the introduction of this pest into uninfested areas of the Island through the medium of nursery stock, no tea plants may be moved from one place to another unless accompanied by a permit. During recent years applications to remove plants have been dealt with by the Plant Pest Inspector, Central Division, on behalf of the Director of Agriculture. From October 1, this duty has been assigned to the Controller of Plant Pests. If the proposed movement of plants is in accordance with the provisions of the regulations governing this pest, permits are issued, being valid for a period of three months from the date of issue. The extensive tea area, which it is desired to protect, is situated in the Dimbula, Nuwara Eliya, Dickoya and Maskeliya districts. A very slight but gradual, encroachment upon this area, by Shot-hole Borer, is taking place on the nothern boundary of the Dimbula district.

During the year, 354 applications to remove tea plants were received, as a result of which 930 permits were issued,

covering 3,233,960 plants. Approximately 60 per cent. of the above applications were received during the last three months of the year subsequent to the abolition of the Plant Pest Inspection Division. The number of plants moved during the past year is the lowest figure since 1924 and it is presumed that the plants were required more for the supply of vacancies than for the planting of new areas.

Two applications for the removal of 20,000 and 5,000 plants, respectively, were refused during 1932, the applications being for permits to transport from infested to non-infested districts.

The regulations relating to this pest were amended in the early part of the year, the infested areas being classified under Chief Headmen's Divisions, thus bringing these regulations in this respect in line with those governing other declared pests. Another important revision has been the abolition of the system of grading of tea nurseries by the Department. The result of these amendments is that a free movement of tea plants is now allowed on permit, within the infested areas, but under no circumstances are permits issued for the movement of plants to, or through, an area which is not infested.

Tea Tortrix (*Homona coffearia*).—The regulations in regard to this pest require that all egg-masses, larvæ and pupæ on tea must be destroyed and, further, that records of the collection of egg-masses on all estates, over 10 acres in extent, must be sent to the Director of Agriculture at intervals not exceeding three months. To facilitate the submission of these returns franked and printed post cards are sent to 1,110 tea estates during the first week of each quarter of the year. The response is very satisfactory, about 96 per cent. of replies being received. In cases where no returns are sent in, the matter is followed up and it is usually found that the estates concerned have no Tea Tortrix to report.

The cards for the first and second quarters of the year were sent to all tea estates by the Inspector, Central Division, and those for the third quarter by the Controller of Plant Pests. The information received has been indexed. The cards for the final quarter of the year were also addressed and prepared for despatch during the first week of January 1933.

The returns during the past few years show a definite decrease in the number of egg-masses collected in most districts as compared with 1927 and 1928 when those regulations were first introduced.

It should be mentioned that the decision to collect the egg-masses of Tea Tortrix was the result of resolutions

passed by the Planters' Associations of the districts in which this pest is most prevalent. This led to a request being made to Government by the Central Planters' Association that this insect should be proclaimed as a pest under the Plant Protection Ordinance of 1924 and that the regulations submitted by this body should be given a trial for a three-year period. The first return was for the period October to December 1927 and at the termination of the trial period Government was asked to extend the trial for a further two years. This period has now expired and its continuance, or otherwise, will require early consideration. The decrease in the numbers of egg-masses in all tea districts is so striking, and the incidence of the pests in the most severely infested districts so very much reduced, that a continued trial of this control measure is very much to be desired. Whether the reduction in the numbers of this severe pest is solely due to the collection of egg-masses, or to a combination of factors, it is not possible to say but it has certainly coincided with the period during which the regulations have been in force.

According to the Report of the Mycological Division for 1932, specimens of root diseases continue to be the commonest received for examination and report. While root diseases are the most important diseases in up-country districts, visits to estates in the low-country have indicated that the major problem there is and will be for some years that of wood-rot or branch canker. Modern methods of pruning will slowly tend to overcome the problem but the results of heavy pruning in the past and the lack of protection of pruning cuts are still to be seen in the deaths of parts of or of whole bushes as the result of wood-rot or branch canker. With the present prices of tea the best method of controlling the disease appears to be the uprooting of the worst affected bushes and replacing them by young plants.

Cereals

Rice

Ceylon.—In the Report by Dr. J. C. Haigh, on the work of the Division of Economic Botany, Department of Agriculture for the year 1932, reference is made to manurial experiments on rice carried out, in conjunction with the Agricultural Chemist, at Peradeniya during the Maha 1931–32 season. Five replications of the following treatments were laid down.

1. Green manure at 1 ton per acre, applied 7 days before transplanting.

2. Superphosphate at 1 cwt. per acre, applied 7 days before transplanting.

3. Superphosphate plus green manure as above, applied 7 days before transplanting.

4. Ammophos 11/45 at 96½ lb. per acre, applied after final levelling.

5. Control plots, no manure.

The ordinary methods of cultivation were adopted and soil samples were taken before the first ploughing and at every stage of the subsequent operations. Further samples were taken at intervals during the growing of the crop. The experiment was further continued during the Yala season of 1932 for observation of residual effects. The Maha crop was harvested in March and the Yala crop in September.

This investigation is also dealt with by Dr. A. W. R. Joachim in his Report on the Work of the Chemical Division for 1932. He points out that the investigation has produced results of great practical value as well as of fundamental scientific importance on paddy cultivation. The experiments have clearly demonstrated the value of ammonium phosphate, superphosphate and green manures, and superphosphate alone in increasing yields of the Maha crop, the mean percentage increases over the controls obtained being as high as 59, 39 and 30 per cent. respectively. No statistically significant increase over the controls were, however, noted in the Yala crop. The beneficial residual effects of phosphoric acid on paddy fields appear, however, to be indicated. The yields of the Yala crop were much lower than those of the Maha.

The examination of the Maha crop analytical data indicates that the rice crop continues to assimilate plant nutrients up to the time of maturity of the grain. This is evident both in the Maha as well as the Yala seasons and is in accordance with the conclusions found in India and elsewhere. In the Maha season, about 50 per cent. of the dry matter, nitrogen, total ash and phosphoric acid were absorbed by the crop at flowering time. In the Yala the amounts so assimilated were much lower, being about 28 per cent. on the average. The mineral constituents potash and lime were absorbed in the Maha season to the extent of about 75 per cent. of the total at harvest. In the Yala, however, the percentage absorbed was only about 35 per cent. The reason for these marked differences would appear to be the shorter growing period between transplanting and flowering in the Yala, viz.: 2½ months as against 3½ months in the Maha. At the Maha harvesting

the grain from Maha crop contained about 75 per cent. of the nitrogen, 90 per cent. of the phosphoric acid, 30 per cent. of the lime and 20 per cent. of the potash of the entire plant. In the Yala the grain contained about the same percentage of nitrogen, a slightly lower percentage of phosphoric acid, and only about 10 per cent. of the potash and 15 per cent. of the lime. The straw contained on the average about 85 per cent. of the potash and 80 per cent. of the lime of the entire plant.

In regard to the percentage composition of the plant at various stages of growth, the data of both the Maha and Yala crop considered as a whole indicate that the various constituents show a decided percentage fall as the crop advances in age. The absolute percentage constituents are in every case lower in the Yala crop than in the Maha, and so are the total fertilising constituents. The average amounts of fertilising constituents taken up by a crop of paddy when cultivated and manured as in this experiment are as follows:

		Nitrogen.	Phosphoric acid.	Potash.	Lime.
		lb. per acre.	*lb. per acre.*	*lb per acre.*	*lb. per acre.*
Maha.	Control plots .	22·4	8·2	34·8	17·0
	Manured plots .	32·2	12·8	46 5	21·6
Yala.	Control plots .	13·1	4·7	20·3	7·1
	Manured plots .	15·8	5·1	22·0	7·6

The above table also demonstrates that the manures have had a decided influence on the total intake of fertilising constituents by the Maha crop, but not by the Yala.

The various treatments affect the composition of the crop at different periods differently. The detailed data indicate that phosphoric acid appears to be the limiting factor of yield on these paddy soils.

Soil changes were studied during the growth of the Maha crop. They indicate that there is an appreciable decrease in total soil nitrogen and carbon at harvesting as compared with that at the start of the experiment, the highest fall in nitrogen being in the case of the controls. The water soluble phosphoric acid and P_H values show no appreciable variation during the growing period in the different plots. The amounts of exchangeable ammonia, potash and lime decrease as the crop advances in growth, especially in the case of the exchangeable ammonia. The full year's results are to be published in *The Tropical Agriculturist.*

An account of an experiment to test the viability of short-aged paddies is also dealt with in Dr. Haigh's report.

Previous investigations (*Ann. Rept. Dept. Agric., Ceylon*, 1930; *Trop. Agric., Ceylon*, vol. lxxvi, No. 6, p. 331) on the viability of long-aged paddies showed that paddy seed loses its power of germination, at first slowly but later much more rapidly, until nineteen months after harvest when it is completely useless. The test has now been repeated with short-aged varieties, varying from three to four and a half months; in each test 400 seeds were used and tests were made every two months.

The results are essentially similar to those obtained with long-aged paddies. From ten to thirteen months after harvest the viability falls rapidly until at a period of sixteen to twenty months after harvest the seed is useless. Yala varieties are normally sown eight or nine months after harvest, and it is, therefore, hopeless to expect a crop from seed that is kept for an extra year. It was found with long-aged paddies that the full germinative capacity is not reached until the seed is about two months old, but one month only is necessary for short-aged varieties.

Sorghum

Gold Coast.—According to the Report of the Director of Agriculture for the period July to December 1932, a collection of the various types of sorghum cultivated in the Northern Territories was made and botanical material sent to the Royal Botanic Gardens, Kew, for identification. It is supposed that with but one or two exceptions all types belong to *Sorghum guineense* Stapf.

Selections and breeding work by the plant to row method with a view to increasing yield, purifying types and eliminating undesirable secondary branching have been in hand for the past two years. Several types breeding true have been isolated and are in process of being further tested. Early maturing types grown in the Northern Province were tested for the same feature in the Southern Province and proved unsuccessful.

Root Crops

Cassava

Gold Coast.—In the Department of Agriculture *Year-Book*, 1930 (Paper No. XXVIII), H. A. Dade outlines preliminary investigations into the problem of cassava mosaic, a virus disease of this crop which for some years past has been on the increase in the Gold Coast. The Director of Agriculture, in his report for the period July to December 1932, states that since that date investigations have been continued but without any very definite con-

clusions being reached. Collections of the various local types were made and those showing the least susceptibility to attack were selected for further trials in infected areas. While some types are less prone to attack than others it would appear that an immune type has yet to be discovered; meantime, however, the work includes the breeding of new types and it is in this direction that success is most likely to be achieved.

Coco-yams

(*Xanthosoma and Colocasia spp.*)

Gold Coast.—A paper by J. Wright giving full details of the work carried out on root-rot of these crops was published in the Department of Agriculture *Year-Book*, 1930 (Paper No. XXII). According to the Report of the Director of Agriculture for the period July to December 1932, the disease continues to increase and is becoming more widespread, so that the question of control becomes more problematic, especially as propagation is by division of root stocks. Investigations have been continued and serve to show that application of wood ashes to the soil does not act as a deterrent to the disease, and the application of potassic fertilisers is equally ineffective as a means of control. In general, *Xanthosoma* spp. only are cultivated as a crop; the older and perhaps indigenous *Colocasia* spp. occur fairly frequently but they are not cultivated owing to the preference given to *Xanthosoma*. After a series of trials in infected areas it has been found that *Colocasia* is immune to the disease, and in view of this, efforts are now being aimed at the breeding of types from this genus, with the object of improving qualities while retaining the disease immune characteristics of the parent.

Fruits

General

Ceylon.—Reference to experiments on the artificial ripening and colouring of fruits carried out by the Chemical Division of the Department of Agriculture, is contained in the Report of the Division for 1932. It is stated that very successful results were obtained with ethylene as well as with acetylene gas. The former was used in the proportion of 1 of gas to 1,000 of air. Fruits of different varieties—oranges, grapefruits, mandarins, plantains, sapodillas, tomatoes—were coloured and ripened in two to five days depending on the nature of the fruit, its degree of maturity, etc. An exposure period of from

eight to twelve hours with an interval of an hour or so between two exposures to allow for aeration of the chamber was found to give the best results. A quantitative experiment with oranges to ascertain whether ethylene gas hastened the ripening, in addition to the colouring of the fruit, indicated that the gas-treated fruit had in every case slightly more acid and less sugar than non-treated fruit analysed at the same time. This investigation will shortly be repeated using larger numbers of oranges for treatment. The acetylene gas was prepared from carbide and water. An ounce of carbide for every 75 c. ft. of " free " air space was the standard worked on, and the results with grape fruit have been very satisfactory. The keeping quality of gas-treated fruit appeared to have appreciably improved as a result of such treatment.

Bananas (Plantains)

Ceylon.—The report of Mr. F. P. Jepson, Controller of Plant Pests, on the work carried out by the Division of Plant Pests during 1932, contains the following references to pests and diseases of plantains in Ceylon.

Root and Stem Weevils (*Cosmopolites sordidus* and *Odoiporus longicollis*).—Although these two pests occur in most, if not all, plantain-growing areas of the Island no cases of severe injury have been recorded during the past year.

Bunchy Top Disease.—No control measures have yet been prescribed for this disease nor have the infested areas of the Island been proclaimed. The disease is reported to have been prevalent in the Matala and Kegalle districts of the Central Division during the year under review, while there has been a corresponding absence of the disease during the same period in the North-Western Division. In the Southern Division occasional cases have been met with throughout the Southern Province, with the exception of the Tissamaharama area of the Magam Pattu in the Hambantota district which is believed to be the only region in the Island, where plantains are cultivated, which is free from the disease.

Plaintain cultivation in this area is conducted on a very extensive scale and, consequently, it is very desirable that steps should be taken to prevent the introduction of the disease into this region which, no doubt, owes its present freedom in this respect partly to its comparative isolation and also to the fact that there is little movement of plantain fruit and plants into these areas from without.

It is now known that the disease is due to a virus which

is transmitted from infected to healthy plants through the agency of the aphid *Pentalonia nigronervosa*. The aphis is, and has been for some years, very common in the plantain plantations of the Tissamaharama area and, consequently, the importation into this region of a single infected plant would probably result in the rapid spread of the disease throughout the district, which would be very serious hardship to those who now depend entirely upon the cultivation of this crop for their livelihood. It is proposed, therefore, to do all that is possible to avert such a misfortune but, in the first place, it is necessary that the supposed immunity from the disease which this region is believed to enjoy should be verified by an extensive inspection of the entire area, a duty which the Mycologist has agreed to undertake in the immediate future.

The disease is one which has already been proclaimed under the Plant Protection Ordinance and, in the event of the Tissamaharama area being found to be definitely free from the disease, immediate steps will be taken to prohibit the movement into this area, from any outside source, of all portions of plants belonging to the genus *Musa* which, in addition to the edible varieties, also includes non-edible forms known to harbour the disease, e.g. *Musa textilis*. Suitable regulations have been drafted, and the infested areas of the Island defined, in order that effect may be given to the above intention with a minimum of delay in the event of the Mycologist's report confirming the present impression that this disease does not occur in the area referred to. As this area is more or less isolated by a deep belt of jungle and is served by a single main road only, the natural advantages of its position, from the view-point under consideration, contribute very materially towards the prospects of being able to maintain it free from this disease for many years to come.

According to the Report of the Mycological Division for 1932, further observations on wilt disease or Panama disease of plantains were made during the year. Successful inoculation experiments were carried out with pure cultures of the fungus *Fusarium cubense* previously isolated from diseased plants. Laboratory experiments have indicated that the progress of the disease is slow in plants grown in good conditions of soil and cultivation. Lack of drainage and poor cultivation favour the rapid spread of the disease.

Field observations of diseased plants in different areas and under different conditions have tended to indicate that there are more than one form of the disease, since the

severity of the disease appears to differ sometimes in similar situations. Further work is necessary before this observation can be confirmed but it may supply an explanation of the fact that the disease sometimes assumes a chronic form.

Field observations have indicated, and controlled experiments have confirmed, that there is a marked difference in the susceptibility of different varieties. The varieties Mondan, Sora-mondan, Kolikuttu and Kathemondan (S. Kitala) are relatively susceptible to the disease while the varieties Embul Hondarawala and Suwendel are relatively resistant to it.

The disease appears most commonly to be spread by the use of infected suckers as planting material. The distribution both of this disease and of bunchy top disease by suckers is the cause of considerable damage, and attention has been given to the discovery of a suitable means for completely destroying diseased plantain stools *in situ*. An experiment was started at the end of the year to determine if any of the heavy oils procurable locally could be used for this purpose in a manner similar to that commonly employed in the West Indies. The value of a cheap, efficient and easy method of destroying diseased plantains would be great.

Citrus

Ceylon.—The following notes relating to Mr. W. C. Lester-Smith's investigations of citrus diseases are contained in the Report on the Work of the Mycological Division, Department of Agriculture, for the year 1932.

Canker.—The occurrence and distribution of citrus canker (*Pseudomonas citri*) have been studied. The disease appears to be widely spread at all elevations below 3,000 ft. It is extremely seasonal, depending mainly on weather conditions and the citrus leaf-miner for its distribution once infection is established. With the above-mentioned restriction in regard to altitude, it is to be found on all citrus plantations of any size; isolated plantations and gardens, the infection of which has been guarded against by natural or artificial means, may remain free from the disease. Where present, it is essential that measures to prevent its spread by spraying should be carried out. Canker is usually most severe on American shaddock seedlings, while mandarin orange, "nataran" and *Citrus megaloxycarpa* appear to be the most resistant species. No totally immune variety has been observed. Further new Ceylon citrus host records for citrus canker have been collected.

Foliocellosis, Chlorosis and Leaf-mottle.—The discovery

of the presence in Ceylon of the citrus root nematode (*Tylenchulus semi-penetrans*) may prove to be of importance. The eelworm has been found on the roots of a number of species of citrus and in almost every case it was associated with symptoms of leaf-mottle or foliocellosis, which is extremely common at both low and medium elevations (up to 4,000 feet) and which may prove to be the precursor of much of the die-back from which citrus has suffered for so long in Ceylon. The type of leaf-mottle which is known as foliocellosis has been attributed in America to this eelworm and its discovery in Ceylon is noteworthy. Preliminary experiments have indicated that the provision of adequate sub-soil drainage and manuring are capable of ameliorating the condition of trees suffering from leaf-mottle, although the improvement may only be temporary. The increase in the number of specimens of citrus diseases received for examination and investigation is indicative of the increasing interest taken in this crop. The diseases received have included storage rots of fruits, gummosis, die-back, sooty mould, mildew, greasy spot, sunburn and mechanical injuries.

Leeward Islands.—*Dominica.*—Mr. F. G. Harcourt, Agricultural Superintendent, reports that the investigational work of his Department during the half-year ended December 31, 1932, was mainly concerned with citrus, and may be conveniently dealt with under the following heads :

1. Breeding Limes.
2. Trials of stocks for Limes.
3. Grapefruit and Orange variety and stock trials.
4. Estate Development work at the Government Fruit Farm.
5. Plant Distribution.

The last head, while not dealing with strictly investigation work, is included, as it indicates the work being done by the Department to replace seedling lime trees with budded trees, and to build up an industry in grapefruit and oranges.

1. *Breeding Limes.*—As has been explained very fully in earlier reports the aim in this work is to raise a variety which will have cropping qualities equal to those of the West Indian lime, and be resistant to Withertip and Blossom blight. The varieties of lime used in this work are West Indian, Woglum and Philippine.

The seedlings, resulting from the first of these crosses which were planted in 1929 and grafted on sour orange

stocks, have nearly all fruited. Eighteen of the most promising were crossed back, with the West Indian lime as the male parent, in 1931. The seedlings produced from this cross number about two hundred, and are being tried on both sour orange and rough lemon stocks.

2. *Trials of Stocks for Limes.*—All citrus trees now being planted in Dominica are budded or grafted, the stock principally used being the sour orange. This stock is not entirely satisfactory in some districts, and trials of rough lemon and grapefruit stocks are being conducted. The young budded trees were planted in 1930, and most of them have yielded a few fruits during the picking season just ended. There are at present little apparent differences in the behaviour of the stocks, except, perhaps, that grapefruit appears to be the most vigorous.

In another trial consisting of two plots of lime trees, one containing West Indian limes *budded* on sour orange stocks and one containing West Indian limes *grafted* on sour orange stocks, planted in 1929, all the trees have made fine growth and have borne small crops of limes. The grafted trees appear to be very slightly larger than the budded ones and more uniform in size and shape.

Lime and other citrus trees budded on rough lemon stocks and to a less extent on grapefruit stocks are being planted on a small scale by planters in various parts of the island, where entire satisfaction has not been obtained with the sour orange.

3. *Grapefruit and Orange, Variety and Stock Trials.*—These trials are being conducted mainly at the Government Fruit Farm, Copt Hall. The following lists indicate the varieties already planted :

Grapefruits : Marsh's Seedless, Duncan, Triumph and Foster.

Oranges : Valencia, Washington Navel, Jaffa, Boone's Early, Pineapple and Portugal.

Tangerine, Satsuma, King Mandarin and Sweet Lime have also been planted. Most of these varieties are being tried on sour orange, rough lemon and grapefruit stocks. Planting began in 1930, and the young trees are growing well. Preparations are being made for adding further varieties for trial.

4. *Estate Development Work at the Government Fruit Farm.*—The Government Fruit Farm, an estate of 181 acres, which was purchased by the Government as a derelict lime and cocoa plantation in 1930, is being cleared, planted and developed as a citrus estate. Twenty acres are used as Demonstration and Trial Grounds. Most of the remaining area is divided into plots of 5 to 10 acres each, and planted

or being planted with grapefruit and oranges, and on coming into commercial bearing will be sold on easy terms to selected local settlers. Some of these Estate Development Plots are on flat riverside lands, some on rather steeply sloping hillsides, and some on fairly high ground; they are representative of the planting lands typical of Dominica.

Detailed costs of each cultural operation performed, such as draining, planting, mulching, etc., are being kept for each individual plot, and it is hoped that these records will provide much useful information for prospective citrus growers.

5. *Plant Distribution.*—The Department is still actively engaged in the propagation and distribution of economic plants to growers, and large nurseries are being maintained for this purpose. Budded citrus were principally in demand, and during the year 1932 31,691 limes, 6,267 grapefruit and 2,679 orange trees were distributed. Agricultural Officers visit growers and advise generally on the planting and after-care of the plants.

Oil Seeds

Coconuts

Ceylon.—The Report of Mr. F. P. Jepson, Controller of Plant Pests, on the work carried out by the Division of Plant Pests during 1932, contains the following references to pests and diseases of coconuts in Ceylon.

Black Beetle (*Oryctes rhinoceros*).—The requirements of the regulations in regard to this pest are entirely directed towards the elimination of media in which the beetle can breed. Without an adequate staff these regulations are extremely difficult to enforce, particularly in closely settled districts where coconut palms are to be found in almost every private garden. Where coconuts are cultivated on an estate scale the necessity for disposing of material which affords breeding grounds for the beetle is, generally, sufficiently appreciated and it is only in obstinate cases of neglect that it becomes necessary to enforce the regulations, and then, only, when such neglect is the cause of complaint on the part of neighbouring planters.

This insect has continued to be the most prevalent coconut pest in all districts from which it has been reported during the past year. In the Central Division it was found to breed extensively, and cause damage in localities where the burial of town refuse or other organic matter was done on a large scale. The Inspector, North-Western Division, has found that the beetle breeds freely in leaf-fall even when

buried as deeply as is possible in estate practice, and he considers that if the burial of fallen leaves is persisted in, an increase in the prevalence of the pest must result. The abnormally heavy rains and high winds, experienced in the Matara district of the Southern Division during August, resulted in a large number of palms being blown down. Prompt steps were taken by the Inspector to persuade the responsible owners to have the fallen palms destroyed before they could provide suitable breeding sites for the beetles. Young palms in the Hambantota district of the same Division suffered considerable damage from this pest during the year, but fortunately a more intimate knowledge of the habits of this insect has resulted in smallholders taking early steps to dispose of dead and decaying palms and thus removing many potential breeding sites of the beetle. It was observed, in the same district, that this insect caused injury to palmyrah palms (*Borassus flabellifer*). The few cases of injury by this pest which have been reported since October have been referred to the Divisional Agricultural Officers concerned who arranged for suitable advice to be given to those who sought it by means of personal visits by their Agricultural Instructors.

Red Weevil (*Rhynchophorus ferrugineus*).—Owners of coconut palms attacked by this pest are required by regulations made under the Plant Protection Ordinance to uproot and destroy them or to treat the infested portions in the manner which has been prescribed. Further, all dead palms must be destroyed to avoid their becoming breeding places for the beetle.

The Plant Inspector, Central Division, reports that, following neglect in the past, serious losses have been caused by this pest during the year, particularly on two estates in the Kandy district on which ninety-three palms were destroyed in a period of six months in spite of the attention of pest gangs employed to make frequent inspections of all palms. Similar injuries are reported by him as occurring in a limited area of the Kegalle district where the pest is widely distributed.

Instances of damage in the North-Western Division were few and not serious, injury occurring only in the case of young palms. Occasional cases of damage are reported from the Galle and Matara districts in the Southern Division. Only one instance of injury due to this pest has been reported to the Controller of Plant Pests during the last three months of the year. A special visit was paid by the nearest Agricultural Instructor to the estate concerned, which was in the Matale district, and advice on the necessary control measures was given by him.

Coconut Caterpillar (*Nephantis serinopa*).—A wide outbreak of this pest occurred in the Puttalem district during the year but was controlled following prompt action by the Inspector, North-Western Division. A slight attack occurred, also, on an estate in the Galle district of the Southern Division. No other cases were reported.

Bud Rot (*Bacillus coli* or *Phytophthora* sp.).—The requirements governing this disease are that affected palms must be felled and the crowns burnt. The Inspector of the Central Division reports that 100 palms were destroyed by this disease on two estates in the Kandy district which had also suffered serious loss during the year on account of Red Weevil injury. An area in the Kegalle district was also affected. The disease has been more prevalent in the North-Western Division than during 1931 but only a few cases are reported from the Southern Division.

In the single case reported since October, a complaint was received that a coconut property in the Kurunegala district was suffering owing to the neglect of the proprietor of the adjacent property to destroy a number of palms affected by this disease. The matter was referred to the Inspector, North-Western Division, who succeeded in persuading the offending party to destroy the diseased palms.

According to the report of Dr. J. C. Hutson, Entomologist to the Department of Agriculture, for 1932, the life history of the Black Beetle (*Oryctes rhinoceros*) was worked out during the year by Mr. de Alwis under Peradeniya outdoor conditions, checked by breeding experiments in the laboratory. Under these conditions the following results were obtained: Egg stage, from 12 to 18 days; larval stage, from about 3 to 4 months, including an inactive period of about 1 to 3 weeks before pupation; pupal period, about 6 to 9 weeks, including a period of about 2 to 3 weeks during which the emerged beetle remains in the pupal cell before coming out to feed. The complete life cycle from egg to beetle is about 5 to 7 months under Peradeniya conditions, but may be somewhat shorter under favourable conditions in coastal areas and at lower elevations in the main coconut areas. To be on the safe side, it is essential that trap pits and other possible breeding places should be examined and cleared once every two months.

The danger of burying or mulching large accumulations of vegetable matter, such as coconut branches, town garbage, etc., must again be emphasised, and this practice is especially liable to breed Black Beetle in the lighter rather

sandy soils of the coastal districts. In such districts all droppings from the trees (except nuts) and coconut logs and stumps should be burnt regularly every two months. In order to compensate for this destruction of valuable humus it is recommended that leguminous green manure crops should be grown in alternate rows between the palms and turned into the soil at least once in every two years, the other rows being then similarly treated in their turn. For fuller information on the Black Beetle, reference should be made to the revised leaflet on this pest to be issued shortly by this Department.

The Report of the Mycological Division for 1932 states that judging by the number of specimens received for examination and report during the year more interest has been taken in the diseases of the coconut palm. Grey blight (*Pestalozzia palmarum*) was common in the North-Western and Western Provinces during the latter part of the year. Outbreaks of this disease seem to be correlated with weather conditions and the disease is commonest in wet weather following a period of drought. It is also commonest where conditions of cultivation are poor and on well-cultivated palms on good soil the disease is rarely, if ever, serious.

Stem-bleeding disease (*Ceratostomella* (*Thielaviopsis*) *paradoxa*) has been reported on several occasions. Prompt treatment by excision and scorching has controlled the disease effectively. There is some evidence that the fungus causing stem-bleeding disease is also the cause of the leaf-break disease which has hitherto been attributed to *Botryodiplodia* sp. Neither disease, however, can be regarded as important economically.

Other specimens examined have been examples of bud-rot (*Phytophthora palmivora*), lightning injury, drought injury and suspected root disease.

The work on the root diseases of coconuts has been limited during the year. A complete year's record of the yields from a group of palms was obtained, and showed that the steady diminution in the yields of the trees recorded previously is being maintained but the diminution appears to be much more slow than is generally believed and asserted.

Gold Coast.—The Director of Agriculture, in his report for the half-year July to December 1932, states that production of copra shows some slight increase, but in general is of poor quality and demands improvement. With this object in view copra producers' co-operative

societies are being formed, and a few of these have already been established in the Eastern Province (Keta area). This is a dry zone where effective sun-drying can be carried out during ten months of the year. The trouble in this area is that a large percentage of immature nuts are utilised for copra.

In the Western Province where general expansion is possible and there are favourable conditions for development, rainfall and relative humidity preclude the possibility of sun-drying at any period of the year. Copra producers' co-operative societies are necessary in this area to raise capital for the erection of artificial dryers which are essential in order to ensure the production of sound copra of standard quality.

Ground-nuts

Gold Coast.—The Director of Agriculture in his report for the half-year July to December 1932, states that various trials are in progress with ground-nuts to ascertain optimum time of planting, methods of cultivation, yields, etc. It is of interest to record that it has been found in Tamale that to turn in a good crop of green manure proves of no more benefit to the crop than ordinary grass fallow. Yields recorded were the highest yet obtained in the Northern Territories, and range from 1,000 to 1,200 lb. (dry nuts in shell) per acre.

Oil extraction tests were carried out at Tamale, utilising the shea mill for the purpose. Ground-nuts were found to contain approximately 44 per cent. of oil to dry weight of kernel, and 38 per cent. of the weight of nuts crushed was obtained as oil. Production costs amounted to £13 5*s*. per ton of oil extracted.

The retail price of ground-nut oil, extracted by local methods, is very high, so that mechanical extraction should prove profitable if sufficiently large supplies of nuts were available to warrant adopting machinery for the purpose. The question of packing oil in four-gallon containers for despatch to local market centres is being investigated with the object of stimulating cultivation of the crop in the Northern Territories.

A scheme is in course of preparation to encourage the development of this crop in the savanna areas of Northern Ashanti, the object being to establish an export industry in those parts of the country which are at present non-productive.

Uganda.—The following account of trials with ground-nuts at the Bukalasa Experiment Station is contained in

a report on the work carried out at that Station during the half-year ending December 31, 1932, furnished by the Director of Agriculture.

A spacing trial gave the following results :

1 × ½ ft.	3,078 lb. per acre.
1 × 1 ,,	2,760 ,, ,, ,,
1 × 1½ ,,	2,522 ,, ,, ,,
1 × 2 ,,	2,168 ,, ,, ,,

These results show a gradation from the wider to the closer spacings, but it is doubtful if any of the differences except that between the widest and the closest will be significant.

Two variety trials were harvested, using Bukalasa Bunch and Virginia Bunch varieties ; in the first experiment the lay-out was by the random block method with six replicates, and the second was the random strip method with ten replicates. The results were as follows :

	1st Trial.	2nd Trial.
Bukalasa Bunch	1,430 lb. per acre.	2,192 lb. per acre.
Virginia Bunch	1,628 ,, ,, ,,	1,896 ,, ,, ,,

It will be seen that the slight yield in favour of the Virginia Bunch variety in the first trial was reversed in the second trial, but neither of these differences are expected to be significant. In fact, after close observations it is thought that these two so-called varieties are one and the same obtained from two different sources, the one being local and the other having been imported from Tanganyika. A new 4 × 4 Latin square was laid down in August, using Virginia Bunch, Philippine Pink, Basse, and N.G.I. varieties; at the close of the year this experiment had not been harvested.

An experiment (a 5 × 5 Latin square) to find the incidence of mosaic disease is in progress. The five different treatments employed are as follows :

Spacing.	Treatment.
1 × 1 ft.	Control.
2 × 2 ,,	Clean weeded.
2 × 2 ,,	Mulched with elephant grass (*Pennisetum purpurascens*) at germination.
2 × 2 ,,	Mulched with elephant grass two months after germination.
2 × 2 ,,	Weeded 6 in. around the plant only.

A count of the number of infected plants will be made at intervals during the growing period for purposes of comparison. At the end of the year only one count had been made, in which the incidence of the disease was much lower on the control plots than either of the others, in fact, the

mulching appears to have increased the incidence of the disease.

The work on ground-nuts conducted at the Serere Experiment Station, according to a report by Mr. P. Chandler, Plantation Manager, for the period July to December 1932, was as follows:

The crop, as a whole, was a moderate one only, compared with that of last year, and fruits were mainly small in size.

During the season "rosette" disease was particularly abundant throughout, and was more noticeable where the stand of plants was in any way at all thin in plots where the seeds had been broadcast, or in the wider-spaced plots of other experiments.

Results obtained from the various plots are given below.

(*a*) *Spacing and Mulching Trials.*—Both the "bunch" and "spreading" types were included in this and three spacings employed, viz. 9 × 9 in., 1 × 1 ft. and 2 × 1 ft.

Taking the spacing first, the "bunch" type showed an advantage over the "spreading" type in the closest (9 × 9 in.), with little between the two at 1 × 1 ft., while the "spreading" was favoured somewhat at 2 × 1 ft.

There was no real significance in favour of mulched over unmulched. What was shown, however, was that the "bunch" type was inclined to respond rather better to mulching than did the "spreading" type. This is brought out in the following figures of the totals from 10 plots, individual plot areas being 36 × 36 ft.

—	Mulched Treatment.			Unmulched Treatment.		
	Yields.			Yields.		
	9 × 9 in.	1 × 1 ft.	2 × 1 ft.	9 × 9 in.	1 × 1 ft.	2 × 1 ft.
	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.
"Bunch" type	458 15	355 2	195 8	401 1	311 4	206 6
"Spreading" type	336 12	307 8	251 13	406 13	331 14	244 2

(*b*) *Variety Trial.*—No significance was shown between the yields in this experiment. The totals of five repetitions in each instance are given below. The individual plots were 1/30 acre, and the spacing 1 × 1 ft.

	lb.	oz.
"Bunch" type:		
From seed mass selected first in 1929	178	9
From seed mass selected first in 1930	180	4
"Spreading" type:		
From seed mass selected first in 1930	168	11
From ordinary bulk seed, 1931 crop	184	2
"Pintos Bar" (a spreading type)	181	8

(c) *Roguing* v. *Normal Cultivation.*—Results from this experiment have so far not yet undergone statistical treatment, but in any case yields were very poor all through.

From the plots undergoing the roguing for "rosette" infected plants only 89 lb. 13 oz. of unshelled fruits were secured, against 94 lb. 2 oz. from the unrogued plots.

Both sets of figures represent the yields from five plots, and individual plots equal to 1/40 acre.

The spreading type of ground-nut was grown.

(d) *Flat* v. *Ridge Cultivation.*—The primary object of this experiment was to obtain costs of harvesting of the "spreading" type by ploughing out, and compare them against the ordinary method with native (bent-handled) hoes, but both crop and experiment were eventually a failure. So much "rosette" disease was present, thus reducing the quantity of vegetative growth, that the work of harvesting was rendered similar to that of harvesting the "bunch" type, an operation which costs considerably less normally.

The yields obtained were 263¼ lb. of unshelled nuts from the half-acre grown on ridges and 137¼ lb. from a similar area grown in the ordinary way.

(e) *Showing the time taken to lift the crop by an E.C. Plough* v. *Midget Cultivator when planted in single rows on ridges, and ploughing out single rows on ridges* v. *double ones.* The "bunch" type of ground-nuts was grown for obtaining the information, the crop being harvested during August.

Results are shown below, the times being expressed in team hours, a team being equal to 3 men and 2 head of oxen.

Area.	Treatment.		Time.	Yield. lb.
1 acre.	E.C. Plough, less breast.	Single row per ridge.	4½ hrs.	947
1 ,,	E.C. Plough, less breast.	Double row per ridge.	5 ,,	1,311
1 ,,	Midget Cultivator, fitted with a 12-in. sweep.	Single row per ridge.	4 ,,	622

The main conclusion formed from this experiment was that the use of the plough was and would be the more satisfactory of the two implements under general conditions. The cultivator used in the manner indicated is very good up to a point, but the soil must be in a suitable condition, just moist only, and there must be a minimum amount of haulm to the crop otherwise clogging within the frame occurs.

From the above figures, as far as the harvesting went, it would appear to be considerably more economical to plant double rows per ridge at the particular spacing (2 ft. × 9 in.), the double-row plot taking very little longer time to lift.

(*f*) *Miniature Variety Trial.*—Five new varieties from South Africa were tried out in this experiment under the names of African, Spanish, No. 68/6 (Spanish selection), Virginia Bunch (S.A.) and Virginia Red.

All except Virginia Red were harvested on August 16, this particular variety not maturing till rather more than a month later.

Yield varied between 1 lb. 4 oz. and 2 lb. 14 oz. per 1/65-acre plot, African and Virginia Bunch (S.A.) proving the best in this small-scale trial.

(*g*) *Bulk Increase Areas.*

(1) *Bunch type :*	*lb.*
(*a*) From seed first mass selected in 1929	4,673 (5 acres)
(*b*) From seed first mass selected in 1930	1,125 (2 acres)
(*c*) From seed first selected in 1930, from bulk on account of size only	2,880 (3 acres)
(2) *Spreading type* ·	
From seed first mass selected in 1930	278½ (2½ acres)
Pintos Bar variety	78½ (1 acre)

The last two on account of taking a longer period to reach maturity suffered considerably from "rosette" disease, which is the main cause of depression in yields.

Oil Palm

Sierra Leone.—Mr. F. C. Deighton, Mycologist, Department of Agriculture, has furnished the following summary of oil-palm work carried out in Sierra Leone during 1932.

Individual tree records of weight of fruit bunches and of fruit contained in them, and plot records of flower production have been kept continuously since 1926 for the Nigerian oil palms which are now in their twelfth year after planting. The yield of fruit fell off in 1929 and 1930, but in 1931 it showed an increase of about 30 per cent. over that of any of the three previous years. The yield in 1932 was slightly less than in 1931, but still high. The average output of fruit per tree in 1932 was 21·6 kg., or 1,620 kg. per acre at the Njala rate of planting of 75 trees per acre, which would yield about 476 kg. of oil.

Periodicity of flowering and fruiting was similar on the whole to that described in previous years. There were two waves of flowering of female inflorescences during the year,

the larger being in the second half, corresponding with two waves of fruit production of which the larger was in the first half of the year; but there was, as before, only one wave of flowering of male inflorescences, with a crest in October–November. As in previous years, over twice as many male inflorescences as female flowered during 1932.

Individual tree records are kept in a similar manner for the three younger plots of native oil-palm types, for a plot of Deli palms which are just coming into bearing, and for six Angola palms. Periodicity of flowering and fruiting is in general similar to that of the Nigerian palms. The yield of the native palms is much less than that of the Nigerian at the same age, but the six Angola palms, now in their sixth year after planting, averaged 31·9 kg. of fruit per tree. No Nigerian tree in its sixth year gave as high a yield as this, and the Angola palms with thin-shelled fruit seem a very promising type.

Fibres

Cotton

Gold Coast.—The Director of Agriculture in his report for the period July to December 1932, states that work on cotton development in the Colony has been aimed at further improving the most promising strain D28—a type of American Upland origin, bred at Tamale. Efforts to the end of the year may be summarised as follows:

(i) D28 has now increased its yield, though slightly, for the third year.

(ii) No other American selection yet approaches this strain for yield, and none shows any great promise at present.

(iii) One Asiatic variety, with poor lint length and ginning percentage, shows distinct promise and early maturity.

(iv) Soil differences in closely adjacent plots were noted to have marked physiological influence on the same strain of cotton.

(v) Bollworm was again the major pest. The comparative resistance of the Asiatic varieties is noteworthy (see Table I below). The incidence of various pests at different periods of the cotton season is of interest (see Table II below).

(vi) The most serious vegetative disease—leaf curl—which was a vital factor in the original Allen cotton, is now practically eliminated from the improved strain (see Table III below).

TABLE I

Percentage Incidence of Disease and Insect Attack in Shed Bolls
1931–32 *Season*

Strain.	Stainer	Bollworm.	Physiological	Other Injuries	Mummied Bolls	Half-developed Bolls shed.
D28 . .	12·5	21 4	20·4	19 5	26 2	2·1
T66/126 . .	13 1	29 8	22 0	19 8	15·3	3·6
Karunganni .	11 0	17 2	31·1	19 3	21 4	2·5
Coconadas . .	10·6	15 5	33 3	13·2	27·4	3·5

TABLE II

Monthly Percentage of Incidence of Disease and Attack Strain D28.
1931–32 *Season*

Month	Stainer	Bollworm	Physiological	Other Injuries	Mummied Bolls	Half-developed Bolls shed
September .	13·3	25 6	34 5	26 4	—	2·5
October . .	17 7	28 5	24 6	28 6	0 6	2 8
November . .	12 7	22·7	21·0	19 1	24 5	2·1
December .	8 5	12 7	13 9	11 5	53 4	2·3
January . .	4 2	10 6	14 2	6 0	65 0	1·7
February . .	2 0	15 0	6 3	2 8	73 9	2·4

TABLE III

Incidence of Leaf Curl in Allen and Strain D28

Month.	Percentage of total number of Plants attacked. Allen	D28.
October	23·2	2·9
November . . .	27 8	3·2
December	40·4	2·1

Jute

Uganda.—In his report for the half-year ending December 31, 1932, Mr. P. Chandler, Plantation Manager, Serere Experiment Station, states that in trials with jute conducted at the Station very few plants attained a height of more than 5½ ft., largely on account of growth being checked by spells of unfavourable weather from time to time.

Some rettings of stems were done, the results of which are given.

Period.	Area	No. of plants	Weight of green material	Weight of dry material		Retting period	Amount of Fibre		Estimated fibre yield per acre.	
	acres		*lb*	*lb*	*oz*	*days*	*lb*	*oz*	*lb.*	*oz.*
82 days from sowing date .	1/121	163	43½	12	14	10	1	1	514	4
96 days from sowing date .	1/121	153	45	12	15	9	1	4	605	0
110 days from sowing date .	1/121	92	43	9	0	9	0	15	453	12
124 days from sowing date .	1/121	173	25½	8	8	9	1	0	665	8

The fibre which resulted from the above treatments proved to be extremely variable both in colour and texture, it being observed that the earlier rettings produced fibre both lighter in colour and less harsh than each subsequent retting.

Samples of string and rope prepared by hand from the jute proved very inferior to samples made from Sunn hemp fibre which had been prepared in a similar way.

Sunn Hemp (*Crotalaria juncea*)

Uganda.—Mr. P. Chandler, Plantation Manager, Serere Experiment Station, in a report for the half-year ending December 31, 1932, states that weather conditions as a whole could not be considered favourable for sunn hemp; frequent dry spells checked growth somewhat, and there were times when the plants really suffered. However, in spite of this many plants attained a good height, 5½ – 7 ft., and the crop presented a healthy appearance until well on in the flowering stage. Some patches of disease were then to be seen, but the plants seemed to grow out of it after a while to a certain extent, especially with spells of more favourable growing weather.

Seed production was ultimately depressed and 654 lb. only were obtained from ¾ acre sown with a 70-lb. seed rate.

During the season some rettings were again made, at corresponding periods to those of last season (see this BULLETIN, 1932, **30**, 219; and this number p. 139), and the following data were collected in respect of green material weight and fibre.

Period	Green Material			Fibre.	
	Area	Total Amount	Estimated yield per acre	Total Amount	Estimated yield per acre.
	Sq yds	lb	lb	lb oz	lb oz
46 days from sowing (early flowering)	40	184	22,264	Too immature	—
108 days from sowing date (early fruiting stage)	40	208	25,168	2 1	249 9
140 days from sowing date (few fruits matured)	40	170	20,570	4 2	499 2
157 days from sowing date	40	148	17,908	3 9	424 13

Rubber

Hevea

Ceylon.—According to the Report on the Work of the Mycological Division, Ceylon, for 1932, the common diseases of Hevea were noted during the year but none of them was unusually prevalent. *Oidium heveæ* (Hevea mildew) was common, especially in mid-country districts, in the early months of the year, but the intensity of the outbreak was no greater than usual.

The rains accompanying the break of the south-west monsoon were somewhat delayed and, in consequence, the attack of leaf and pod disease caused by *Phytophthora palmivora* was relatively slight, particularly when compared with that which occurred in 1931. The fungus, however, continues to do considerable damage by attacking and causing the death of young shoots in bud-wood nurseries and in young clearings. Bud-wood nurseries should be sprayed with a standard fungicide at weekly intervals during wet weather. Such spraying has given efficient control of the disease.

The continued state of depression and the low market prices of rubber have resulted in the placing of a number of rubber estates on an "upkeep basis." On such estates the work on the control of diseases is of necessity reduced to a minimum but visits paid to typical estates during the year have indicated clearly that the control of certain diseases, particularly of root diseases, may be necessary if considerable losses are to be avoided. In normal times work on the control of root diseases is undertaken as a routine measure and it is rarely that large areas are involved since prompt treatment prevents the spread of disease. It is strongly recommended that, even on estates which are out of tapping, an economical form of treatment of root disease, especially that caused by *Fomes lignosus*, be maintained. If this is not done control

may prove to be extremely difficult and expensive when conditions do improve. Fortunately, apart from root diseases, there are few diseases which are likely to become more serious when estates are rested.

In connection with the experiment on the poisoning of rubber trees referred to in the last two annual reports it is of interest to note that, whereas the tree which was ringed and poisoned died within three months, the tree which was ringed by the removal of a band of six inches of cortex down to the wood was still living after thirty months. There is no organic connection between the cortex of the lower and upper part of the tree. It is obvious, therefore, that the application of poison to a ringed tree is of considerable assistance in hastening the death of the tree.

Some trouble has been experienced in the dying back of young budded plants from the cut end of the stock. The rotting of the stock may be caused by a number of wood-rotting fungi and in extreme cases the bud-shoot may be killed at the junction with the stock. The disease is commonest where old stocks (over 2 years old) have been used for budding, where the vigour of the budded plants is poor and the growth of the callus consequently slow, and where the cut surface has not been adequately protected. The disease can be avoided by the use of young stocks, by manuring to induce rapid healing and by protecting the cut surface of the stock with a plastic wound cover. Where the die-back has already commenced, all dead tissue must be excised and the wound first painted with a disinfectant solution and then covered with a protective wound cover, e.g. Skene's wax. The improvement of conditions of cultivation will induce the rapid formation of callus and the covering of the wounds.

No new disease was recorded during the year.

Tobacco

Ceylon.—According to the Report of Dr. J. C. Hutson, Entomologist to the Department of Agriculture, Ceylon, for 1932, an investigation of the tobacco stem-borer (*Phthorimæa heliopa*) was started during the second half of the year and is still in progress. The eggs are usually laid singly on the leaves of seedlings in the nursery beds and the caterpillars tunnel into the leaves and make their way inside the leaf-stalks down into the stem which becomes swollen. The young leaves become stunted to form a "rosette" and the plants fail to make a normal growth. The caterpillars pupate inside the stem, leaving only a thin membrane for the emerging moths to break through. In

older plants with fully developed leaves the caterpillars may feed inside the fleshy midrib where they pupate. Vigorous plants of some of the local varieties of tobacco, such as Hiriyala, can sustain a fairly heavy attack in both the leaves and stems without the crop being seriously affected, but some of the better imported varieties, such as White Burley, do not come off so well. The usual control measures recommended are (1) the weeding out and burning of attacked plants in the seed beds and after transplanting; (2) the slitting of the stems and the removal of larvæ and pupæ from older and more vigorous plants in the field; and (3) the destruction of the crop refuse by pulling up and burning immediately after the harvest. Inspections made by the Entomologist of village tobacco areas in the North-Western Division indicated that the second measure is sometimes carried out, but no attempt seems to be made to remove either infested or diseased plants or to destroy the crop refuse soon after harvest. This last measure is not considered necessary by the cultivators since only one crop is grown annually in many areas; the stalks are pulled up later if the land is required for some other crop. Nursery beds of tobacco seedlings were sprayed with a miscible oil and with lead arsenate with the object of killing the eggs and poisoning the young caterpillars, but there is no definite evidence so far that this measure has been successful. The bionomics of this pest are being studied by Mr. de Alwis, and further attempts will be made to try to control the pest by insecticidal methods.

The Report of the Mycological Division for 1932 states that diseases of tobacco received attention during the year, the work being in the hands of Mr. W. C. Lester-Smith up to the time of his transfer. Investigation of the Ceylon diseases is still in its early stages, but a number of observations have been made.

Bacterial wilt (*B. solanacearum*) is the most important of the Ceylon diseases. It occurs in all tobacco-growing areas. It has been shown that the use of lime as a fertiliser has in some districts, particularly on sandy soil, had the effect of inducing alkalinity in the soil and of favouring the increase of the disease. A number of determinations of the soil acidity have been made of soils in which the disease occurred and, although the disease has been found also to occur in more acid soils, there appears to be some correlation between the severity of attack and the alkalinity or high hydrogen-ion concentration of the soil. The use of the same soil for growing tobacco in successive seasons has in some areas induced severe attacks

of bacterial wilt. The importance of a suitable rotation of crops has been emphasised.

The identification and classification of virus diseases of tobacco has been commenced. Work done has been of a preliminary nature, and that there is a need for continuous and long-range research work on these diseases is obvious. The discovery of wild hosts of these diseases is of importance.

Drugs

Kola

Sierra Leone.—Mr. E. J. Nisbett, Agricultural Officer, Njala, in a report on the work of the Njala Agricultural Station for 1932, states that a trial is being carried out on kola to find out the effect of "spiralling" and root pruning the trees. Root pruning was done by digging out a trench round the tree just within the spread of the branches and of a sufficient depth to expose all spreading roots which were then severed. "Spiralling" was done by cutting out a strip of bark about an inch wide in a spiral from just above ground level to the main fork, the turns of the spiral being about a foot apart, and ensuring that the tree was completely encircled. The treatment was carried out in May 1931. The "spiralled" trees have given a substantial increase in yield; the root pruning has shown no significant effect.

MINERAL RESOURCES

UGANDA

The Imperial Institute has received from the Director the following report on the work carried out by the Geological Survey of Uganda during the second six months of 1932.

The Director visited Oldoway, in Tanganyika Territory, to give his opinion with regard to the age of the skeletal human remains originally discovered by Professor Hans Reck in 1913, and over which a controversy as to the contemporaneity of the remains, with the deposits in which they were found, has arisen in the scientific press. The conclusions arrived at will be discussed briefly in the Annual Report of this Department for the year 1932 which will be published shortly. In the meantime it may be mentioned that the skeleton belongs to antiquity and in all probability is of Kenya Aurignacean date.

Investigations into the problem of lost alluvials in the Kagera valley and associated tributaries were carried out. These enquiries were made with particular reference to the occurrence of alluvial tin and the effect of river reversal in

relation to the subject were considered. During the course of the work important archæological discoveries, pertaining to the proper understanding of geological events during Pleistocene times, were made.

A visit was paid to the tin occurrence at Kaina and Lutobo in south-west Ankole and advice rendered as to further prospection.

Sango Bay, in southern Buddu, was visited and data collected with regard to the Pleistocene terraces and wave-cut benches of Lake Victoria.

Mr. A. D. Combe continued his prospecting reconnaissance of parts of the districts of Ankole and Toro in the Western Province. Gold was found to be widely distributed throughout the alluvials of many of the rivers in the counties of Buhwezhu, Kitagwenda, Kibale and Kitagweta and in the gravels of some of the valley flats in the Bwizibwere-Maseruka area. In most of the concentrates from the Maseruka area monazite is present, while it was found to be particularly abundant in the gravels underlying the swamp immediately west of Maseruka. The sources of the gold have yet to be located and much further work, including boring, will have to be carried out.

Dr. K. A. Davies, having returned from leave on June 29, visited Tororo, in Budama, in July to indicate the most suitable localities for quarrying limestone which is required for manurial purposes in the Trans-Nzoia district of Kenya Colony.

The Karroo areas around Bugiri and Bulugwe in the Busoga district of the Eastern Province were delineated.

The major portion of the second half-year was spent by Dr. Davies in prospecting parts of the Budama District in the same province. Gold was found in the gravels of many of the streams, particularly near the boundaries of the sedimentaries and the igneous rocks. Gold in payable quantities was found in the alluvials of the Walupe river—a stream on the borders of Budama (in Uganda) and Trans-Nzoia (in Kenya). The source of the stream, however, lies in Kenya.

The laboratory work has considerably increased and Mr. Simmonds has dealt with a record number of specimens. The increased interest in public prospecting was maintained throughout the year, and new occurrences of tinstone, wolfram, bismuth, gold and other minerals have been found and are being actively prospected. Despite the shortage of staff, numerous laboratory investigations have been carried out, and details will be found in the Annual Report of the Geological Survey for the year 1932 which will be published shortly.

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AGRICULTURE

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Feeding the Dairy Herd. By J. T. Armstrong. *Tasmanian Journ. Agric.* (1933, **4**, 37–50).

Alimentación y Cuido del Ganado Vacunos en Puerto Rico. By W. M. Ellison. *Circ. No.* 97, *Estacion Exper. Insular, Dept. de Agric. y Comercio, Puerto Rico.* Pp. 67, 9 × 6. (Rio Piedras: Estacion

Experimental Insular, 1932.) Deals with the feeding and care of dairy cattle in Porto Rico.

Report of the Reorganisation Commission for Milk. *Bull. No. 38, Econ. Ser., Min. Agric. and Fisheries.* Pp. 228, 9¾ × 6. (London: H.M. Stationery Office, 1933.) Price 6*d*. The report is the result of the work carried out by the Commission on the preparation of schemes, applicable to England and Wales, for regulating the marketing of milk.

The Production, Care and Handling of Milk and Cream. By H. B. Davel. *Bull.* 113, *Dept. Agric., Union of S. Africa.* Pp. 20, 9½ × 6. (Pretoria: Government Printer, 1932.) Price 3*d*.

Cost of Production of Milk in Bombay. By A. K. B. Cazi. *Poona Agric. College Mag.* (1933, **24**, No. 4, 17–31).

The Chemical Composition and Nutritive Properties of Milk as Affected by the Level of Protein Feeding. Part I. Chemical Composition. By A. E. Perkins. Part II. Nutritive Properties. By W. E. Krauss and C. C. Hayden. *Bull.* 515, *Ohio Agric. Exper. Sta.* Pp. 69, 9 × 6. (Wooster: Agricultural Experiment Station, 1932.)

Studies on the Nutritive Value of Milk. The Effect of Pasteurisation on Some of the Nutritive Properties of Milk. By W. E. Krauss, J. H. Erb and R. G. Washburn. *Bull.* 518, *Ohio Agric. Exper. Sta.* Pp. 33, 9 × 6. (Wooster: Agricultural Experiment Station, 1933.)

The Food Value of Milk. *Bull.* 340 *Connecticut Agric. and Exper. Sta.* Pp. 30, 9 × 6. (New Haven: Agricultural Experiment Station, 1932.)

Butter, Cream Cheese and Scalded Cream. *Bull. No.* 57, *Min. Agric. and Fisheries.* Pp. 20, 9¾ × 6. (London: H.M. Stationery Office, 1933.) Price 6*d*. Deals principally with the preparation of these products.

Cheddar Cheese. *Adv. Leafl. No.* 156, *Min. Agric. and Fisheries.* Pp. 4, 8½ × 5½. (London: H.M. Stationery Office, 1933.) Price 1*d*.

Fattening Lambs on Corn, Milo, Hegari, Wheat and Oats, with Cottonseed Cake and Alfalfa. By A. K. Mackey and J. M. Jones. *Bull. No.* 465, *Texas Agric. Exper. Sta.* Pp. 20, 9 × 6. (Brazos County: State College, 1932.)

The Sheep Blowfly Problem in Australia. Report No. 1 by the Joint Blowfly Committee appointed by the Council for Scientific and Industrial Research and the New South Wales Department of Agriculture. *Pamphlet No.* 37, *Counc. Sci. Indust. Res., Australia.* Pp. 136, 9½ × 6. (Melbourne: Government Printer, 1933.)

The External Parasites of Sheep. By F. H. S. Roberts. *Queensland Agric. Journ.* (1933, **39**, 84–90). Descriptions, with suggested methods of control, of the principal external parasites of sheep in Queensland.

The Sheep Tick and Its Eradication by Dipping. By M. Imes. *Farmers' Bull. No.* 798 *(Revised), U.S. Dept. Agric.* Pp. 22, 9 × 6. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1932.) Price 5 cents.

Researches in Dips and Dipping. Lime-Sulphur Dips. Paper I. General Introduction. By H. Graf and T. J. Wilkin-Jorden. Paper II. A New Laboratory Method of Chemical Analysis. By T. J. Wilkin-Jorden. Paper III. A Preliminary Study of a Colorimetric Method as a Rapid Means of Control of Polysulphide Solutions. By T. J. Wilkin-Jorden. *Eighteenth Report of the Director of Veterinary Services and Animal Industry, Onderstepoort, Pretoria, Department of Agriculture, Union of South Africa, Part II*, pp. 1005–1035.

Crotalariosis of Sheep. By D. G. Steyn and G. de Kock. *Eighteenth Report of the Director of Veterinary Services and Animal Industry, Onderstepoort, Pretoria, Department of Agriculture, Union of South*

Africa, Part II, pp. 947–953. Results of feeding *Crotalaria dura* to sheep.

The Hide and Skin Industry of the Union of South Africa. By C. H. Neveling. *Farming in S. Africa* (1933, **8**, 63–64).

The South African Export Poultry Industry. By J. J. Jordaan, A. J. Beyleveld and C. H. Spanner. *Farming in S. Africa* (1933, **8**, 57–58; 62).

Industrialización de Huevos. By P. M. Lees. Pp. 34, 9½ × 6½. (Montevideo: Estación Experimental de Frio de la Facultad de Agronomía, 1932.) An account of the development of the egg industry in Uruguay.

Marketing Eggs. By R. R. Slocum. *Farmers' Bull. No.* 1378, *U.S. Dept. Agric.* Pp. 29, 9¼ × 5¾. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1932.) Price 5 cents.

The Quantities of Vitamin A required by Pullets for Maintenance and for Egg Production. By R. M. Sherwood and G. S. Fraps. *Bull. No.* 468, *Texas Agric. Exper. Sta.* Pp. 19, 9 × 6. (Brazos County: State College, 1932.)

Beekeeping in the Clover Region. By E. F. Phillips, G. S. Demuth and J. I. Hambleton. *Farmers' Bull. No.* 1215, *U.S. Dept. Agric.* Pp. 22, 9 × 6. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1932.) Price 5 cents.

Problemas Apícolas de Puerto Rico. By D. A. Rodriguez. *Circ. No.* 99, *Estacion Exper. Insular, Dept. de Agric. y Comercio, Puerto Rico.* Pp. 22, 9 × 6. (Rio Piedras: Estacion Experimental Insular, 1932.) Deals with beekeeping problems in Porto Rico.

Edible Mollusks of Manila. By F. Talavera and L. A. Faustino. *Philippine Journ. Sci.* (1933, **50**, 1–48). Describes with notes on their collection and utilisation a large number of varieties. Includes 18 plates of illustrations.

Forestry

General

Thirteenth Annual Report of the Forests Commission of Victoria, Australia, for the financial year, 1931–32. Pp. 21, 13½ × 8¼. (Melbourne: Government Printer, 1932.) Price 1*s.*

Forestry Development in South Africa and Annual Report of the Department of Forestry, Union of South Africa, for the year ended March 31, 1932. Pp. [illegible], 13 × 8¼. (Pretoria: Government Printer, 1933.) Price 4*s.* 6*d.*

Processus de Régression de la Grande Forêt Equatoriale. Observations et Suggestions Diverses. Mission d'Études Forestières dans la Région du Nord-Cameroun. By J. A. Rousseau. *Bull. de l'Ag. Gén. des Col.* (1932, **25**, 1766–1823). A survey of the various types of forest in the French Cameroons.

Report of the Director of Forestry, Canada, 1931–2. Pp. 19, 9¾ × 6½. (Ottawa: King's Printer, 1932.)

L'Exploitation Forestière à la Guyane Française. By G. Chatelain. *Actes et Comptes Rendus de l'Assoc. Col. Sci.* (1932, **8**, 217–222). Deals with various forest products of French Guiana, including timber and tanning materials.

Forest Research in India, 1931–32. Part II. Provincial Reports. Pp. 155, 9¾ × 6½. (Calcutta: Government of India, Central Publication Branch, 1933.) Price Rs. 2–14 or 5s. 3*d.*

Progress Report of Forest Administration in the Province of Assam, India, for the year 1931–32. Pp. 77, 13½ × 8½. (Shillong: Government Press, 1932.) Price Rs. 2–15 or 4*s.* 4*d.*

Report of the Forest Administration in Baluchistan for the year

1931–32. Pp. 44, 9¾ × 6¼. (Calcutta: Government of India Central Publication Branch, 1933.) Price Rs. 6-4 or 10s.

Annual Progress Report on Forest Administration in the Province of Bihar and Orissa for the year 1931–32. Pp. 79, 13¼ × 8¼. (Patna: Superintendent, Government Printing, 1932.) Price Rs. 3.

The Forests of the Orissa States. By H. F. Mooney. *Ind. Forester* (1933, **59**, 200–221).

Annual Forest Administration Report of the Bombay Presidency including Sind, for the year 1931–32. Pt. I. Pp. 70, 9½ × 6. (Bombay: Superintendent, Government Printing and Stationery, 1933.) Price 6 annas or 8*d*.

Report on the Forest Administration in the Utilisation Circle, Burma, for the year ended March 31, 1932. Pp. 70, 9¾ × 6¼. (Rangoon: Superintendent, Government Printing and Stationery 1932.) Price Rs. 3 or 4*s*. 6*d*.

Report on the Forest Administration in the Utilisation Circle, Burma, for the year ended March 31, 1932. Pp. 70, 9¾ × 6¼. (Rangoon. Superintendent, Government Printing and Stationery, 1932.) Price Rs. 3 or 4*s*. 6*d*.

Annual Report on Working Plans Silviculture and Entomology in Burma, for the year 1931–32. Pp. 73, 9¾ × 7½. (Rangoon: Superintendent, Government Printing and Stationery, 1933.) Price Rs. 2 or 3*s*.

Progress Report of the Forest Administration in Coorg in 1931–32. Pp. 32, 9¾ × 6¼. (Bangalore. Mysore Residency Press, 1932.) Price Re. 1.

Progress Report on Forest Administration in the Punjab for the year 1931–32. Pp. 120, 10 × 7. (Lahore: Superintendent, Government Printing, 1933.) Price Rs. 3-14 or 5*s*. 10*d*.

Annual Progress Report of Forest Administration in the United Provinces for the period April 1, 1931, to March 31, 1932. Pp. 73, 9¾ × 6¼. (Allahabad: Superintendent, Printing and Stationery, 1932.) Price Rs. 2–12.

La Milizia Forestale Nell'Anno X. Pp. 46, 12¾ × 9. (Rome: Commandante della Milizia Nationale Forestale, 1933.) A report of the work carried out in Italy by the Forest Militia during 1932.

Annual Report of the Director of Forestry of the Philippine Islands for the fiscal year ended December 31, 1931. Pp. 382, 9 × 6. (Manila. Bureau of Printing, 1932.)

Making Woodlands Profitable in the Southern States. By W. R. Mattoon. *Farmers' Bull. No. 1071 (Revised), U.S. Dept. Agric.* Pp. 30, 9 × 6. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1932.) Price 5 cents.

Forestry Practice. A Summary of Methods of Establishing Forest Nurseries and Plantations with Advice on other Forestry Questions for Owners and Agents. *Forestry Commission Bull. No. 14.* Pp. 108, 9½ × 6. (London: H.M. Stationery Office, 1933.) Price 2*s*.

The Importance of the Origin of Seed Used in Forestry. By H. G. Champion. *Indian Forest Records (Silviculture Series), Vol. XVII, Pt. V.* Pp. 76, 9¾ × 7½. (Calcutta. Government of India Central Publication Branch, 1933.)

The Better Utilisation of Forests for Grazing. *Indian Forester* (1933, **59**, 127–134).

Wortelstudien in de Tropen. I. De Jeugdontwikkeling van het Wortelstelsel van een Zeventigtal Boomen en Groenbemesters. By I. C. Coster. *Korte Med No. 29, van het Boschbouwproefsta., Dept. v. Landb., Nijverheid en Handel in Ned.-Indië.* Pp. 46, 9½ × 6¼. (Buitenzorg: Archipel Drukkerij, 1932.) A study of the growth of young roots of trees and green manure plants in the tropics.

Wortelstudiën in de Tropen. II. Het Wortelstelsel op Ouderen Leeftijd. III. De Zuurstofbekoefte van het Wortelstelsel. By I. C. Coster. *Korte Med. No. 31, van het Boschbouwproefsta., Dept. v Landb., Nijverheid en Handel in Ned.-Indie.* Pp. 46, 9½ × 6¾. (Buitenzorg: Archipel Drukkerij, 1932.) Study of root-growth in the tropics with reference to growth of old tree roots and the oxygen requirements of roots.

The Mukushi (*Baikiaea plurijuga* Harms) Forests of Northern Rhodesia. By J. D. Martin. *Second Annual Bull., Dept. Agric., N. Rhodesia*, pp. 71–76.

The Sutlej Deodar (*Cedrus Deodara*). Its Ecology and Timber Production. By R. Maclagan Gorrie. *Indian For. Records (Silviculture Series)*, 1933, *Vol. XVII, Part IV*. Pp. 140, 9¾ × 7¼. (Calcutta: Government of India Central Publication Branch, 1933.) Price Rs. 3–2 or 5*s*. 6*d*. See abstract, p. 225.

I. Cultivo de *Pinus pinea* (Piñonero) en el Urugay. II. Composición y Rendimiento de su Fruto. By P. M. Lees and M. Quinteros. Pp. 14, 9½ × 6¼. (Montevideo, 1932.) Reprinted from *Rev. de la Facultad de Agron.*, 1932, No. 6.

Tasmanian Soils in Relation to Tree Growth in Plantations of *Pinus radiata* (*insignis*) and other Exotics. By C. G. Stephens. *Journ. Counc. Sci. Indust. Res., Australia* (1933, **6**, 54–60).

Les Pins Français. By F. Durand-Dronchat. *Parfumerie Moderne* (1933, **27**, 117–125). A brief description of the various species of pine in France with an account of the products derived from them.

Black Walnut for Timber and Nuts. By W. R. Mattoon and C. A. Reed. *Farmers' Bull. No. 1392, U.S. Dept. Agric.* Pp. 27, 9 × 6. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1933.) Price 5 cents.

Report on Spruce Aphis Investigation for the year ending December 1930. By L. J. Dumbleton. *Bull. No. 1, Forest Biological Res. Sta., Cawthron Institute, New Zealand.* Pp. 14, 10 × 6¼. (Nelson: Cawthron Institute, 1932.) Reprinted from *New Zealand Journ. Sci. Tech.*, 1932, Vol. 14, No. 4.

The Phoracantha Beetle, a Pest of Eucalyptus Trees. By F. G. C. Tooke. *Reprint No. 5, 1932, Dept. Agric., Union of S. Africa.* Pp. 5, 9¼ × 7¼. Reprinted from *Farming in South Africa*, January 1932.

Timbers

Report on Census of Production of Home-Grown Timber, 1930. Issued by the Forestry Commission. Pp. 13, 9½ × 6. (London: H.M. Stationery Office, 1932.) Price 3*d*.

Report on the Lumber Industry in Canada, 1931. *For. Prod. Branch, Bureau of Statistics, Dept. Trade and Commerce, Canada.* Pp. 13, 14 × 8½. (Ottawa: Department of Trade and Commerce, 1933.) Mimeographed copy.

Premier Complément à l'Étude Physique et Mécanique des Bois Coloniaux. *Actes et Comptes Rendus de l'Assoc. Col. Sci.* (1932, **8**, 223–233). Includes tables giving the mechanical and physical characteristics of over forty different French Colonial woods.

The Structure and Botanical Identity of Some Scented Woods from the East. By C. R. Metcalfe. *Kew Bull.* (1933, No. 1, 3–15). Deals with the following woods: *Aquilaria Agallocha* Roxb., *Aquilaria malaccensis* Lamk., *Excœcaria africana* Muell. Arg., *Excœcaria Agallocha* L., *Euphorbia antiquorum* L., *Gonystylus bancanus* (Miq.) Baill., *Cordia fragrantissima* Kurz, *Mansonia Gagei* J. R. Drumm. and *Cinnamosma fragrans* Baill. Brief notes on the uses, etc., of the woods are included in some instances.

Photographs of the Timbers of Burma as seen through a Hand Lens, with a Key to their Identification and Reprints of Chief Data on Supplies Qualities, Relative Prices, etc *Burma Forest Bulletin No.* 30 (*Includes a Revised Reprint of Forest Bulletin No.* 22). Pp. 19 + 10 Plates, $9\frac{3}{4} \times 7\frac{1}{4}$ (Rangoon: Superintendent, Government Printing and Stationery, 1932.) Price Rs. 1-4 or 1*s*. 11*d*.

American Cypress (*Taxodium distichum*) and its Uses. *Bull. No.* 141, *Trade Promotion Series, U.S. Dept. Commerce.* Pp. 28, $9\frac{1}{4} \times 6$. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1932). Price 5 cents.

Le Bois de *Guarea Thompsonii*, Succédané du Bossé. By D. Normand. *Rev. Bot. Appl. et d'Agric. Trop.* (1933, **13**, No. 137, 23–30). An account of the wood, its properties and use.

Timber Tests: Meranti temak (*Shorea hypochra* Hance). Tests on small Clear Specimens in a Green Condition made at the Timber Research Laboratories, Sentul. *Malayan Forester* (1933, **2**, 42–45).

The Wood of *Sarcosperma paniculatum*. By H. F. Marco. *Trop. Woods* (1933, No. 33, 1–4). An account of the characters of the tree and the wood.

Dry Kiln Practice. By H. L. Henderson. *Tech. Pub. No.* 38, *New York State College of Forestry.* Pp. 190, 9×6. (Syracuse, New York: College of Forestry, 1932.) Price 50 cents.

Combined Air and Kiln Seasoning. Handling by Means of the Christensen Truck. *Trade Circ. No.* 12, *Div. For. Products, Counc. Sci. Indust. Res., Australia.* Pp. 13, $9\frac{1}{2} \times 6$. (Melbourne: Government Printer, 1932.)

Wood Borers in Australia. Pt. II. *Anobium*, or the Furniture Borer. *Trade Circ. No.* 11, *Div. For. Products, Counc. Sci. Indust. Res., Australia* Pp. 14, $9\frac{1}{2} \times 6$. (Melbourne: Government Printer, 1932.) An account of the occurrence, life history, damage caused and methods of control and eradication of this borer.

Measurements of the Damage to Teak Timber by the Beehole Borer Moth, *Xyleutes* (*Duomitus*) *ceramicus*, with Special Reference to Relative Severity in Plantations and Natural Forest, and to Variation with Rainfall and Position in the Tree. By C. W. Scott. *Burma Forest Bull. No.* 29. Pp 38, $9\frac{3}{4} \times 6\frac{1}{2}$. (Rangoon: Superintendent, Government Printing and Stationery, 1932.) Price Rs. 2 or 3*s*.

The Liability of Some Indian Timbers to Lyctus Attack. By K. A. Chowdhury. *Indian Forester* (1933, **59**, 164–170).

Lyctus Beetles in India. By C. F. C. Beeson. *Indian Forester* (1933, **59**, 158–164).

Causes of Brashness in Wood. By H Koehler. *Tech. Bull. No.* 342, *U.S. Dept. Agric.* Pp. 39, 9×6. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1933.) Price 5 cents.

Tests of Chemical Treatment for Control of Sap Stain and Mold in Southern Lumber. By R. M. Lindgren, T. C. Scheffer and A. D. Chapman. *Indust. Eng. Chem.* (1933, **25**, 72–75).

Specific Gravity and Related Properties of Softwood Lumber. By E. C. Peck. *Tech. Bull. No.* 343, *U.S. Dept. Agric.* Pp. 24, 9×6. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1933.) Price 5 cents.

Composition of Some Philippine Hardwoods. IV. By H. M. Curran, F. M. Yenko, L. Baens and A. P. West. *Philippine Journ. Sci.* (1932, **49**, 587–592). The following woods are dealt with: Kayatau (*Dysoxylum turczaninowii* C. DC.), Lago (*Pygeum vulgare* (Koehne) Merr.), Lamóg (*Planchonia spectabilis* Merr.), Binggas (*Terminalia comintana* (Blanco) Merr.), Bolon (*Alphonsea arborea* (Blanco) Merr.), Kariskis (*Albizzia lebbekoides* (DC.) Benth.), Bayanti (*Aglaia*

llanosiana C.DC.), Bayok (*Pterospermum diversifolium* Blume), Kulatiñgan (*Pterospermum obliquum* Blanco) and Narra (*Pterocarpus indicus* Willd.).

The Chemistry of Cellulose and Wood. A Five-year Review of Investigations dealing with some Fundamental Aspects of the Problem. By H. Hibbert. *Pulp and Paper, Canada* (1933, **34**, No. 2, 100–102). Includes a bibliography of over sixty references.

Products from Wood. A Compilation of Information from Various Periodicals from 1930 to 1931, issued by the Royal Swedish Institute for Engineering Research. Pp. 113, 9½ × 6½. (Stockholm: Royal Swedish Institute, 1932.) In Swedish, but with summary of each section in English.

Notes on the Development of the Manufacture of Sugar and Alcohol from Wood. By A. Hunter. *Paper Trade Journ* (1933, **96**, No. 11, 20–22).

Gums and Resins

Report on the Kauri gum Industry of New Zealand for the year ended March 31, 1932. Pp. 3, 13½ × 8½. (Wellington: Government Printer, 1932.) Price 3*d*.

The Present Position of the Lac Industry in India. By C. Narasimha Acharya. *Madras Agric. Journ* (1933, **21**, 16–27).

The Indian Lac Industry. By T. Hedley Barry. *Paint Manufacture* (1933, **3**, 40–43).

Resin Secretion on Different Host Plants by the Lac Insect. By M. Venugopalan. *Bull No. 11, Ind Lac Res. Inst.* Pp. 11, 9¾ × 7¼. (Namkum, Ranchi: Indian Lac Research Institute, 1932.) Price 8 annas.

Tanning Materials

Die Gambirkultur auf Ostsumatra. By B. Geiger. *Tropenpflanzer* (1933, **36**, 65–72). Cultivation of gambier in East Sumatra.

Terminalia pallida as a Tanning Material. By K. Seshachalam Chondary. *Journ. Intern. Soc. Leather Trades Chem.* (1933, **17**, 68–70).

Development of the Wattle Bark Industry in South Africa. Marketing Prospects for the Future. By W. F. Watt and A. J. Beyleveld. *Farming in S. Africa* (1933, **8**, 83–84, 86).

Some Notes on Wattle Barks and Tannin Extraction. By F. A. Coombs. *Journ. Intern. Soc. Leather Trades Chem.* (1933, **17**, 90–107).

NOTICES OF RECENT LITERATURE

Books for review should be addressed to "The Editor," Bulletin of the Imperial Institute, South Kensington, London, S.W.7.

COMMERCIAL TIMBERS OF INDIA: THEIR DISTRIBUTION, SUPPLIES, ANATOMICAL STRUCTURE, PHYSICAL AND MECHANICAL PROPERTIES AND USES. By R. S. Pearson, C.I.E., F.L.S., formerly Forest Economist, Forest Research Institute, Dehra Dun, India; Director, Forest Products Research Laboratory, Department of Scientific and

Industrial Research, England; and H. P. Brown, Ph.D., formerly in charge, Section of Wood Technology, Forest Research Institute, Dehra Dun, India; Professor of Wood Technology, New York State College of Forestry, Syracuse University, U.S.A. Vol. I, pp. xliv + 548; Vol. II, pp. 549–1150. (Calcutta: Government of India, Central Publication Branch, 1932.) Price £5.

This fine work which has been awaited with so much interest appears as two imposing volumes and at once takes a high place in the literature dealing with the structure and characters of timbers. The publication of the book, moreover, is well timed, for at no period has more or so serious attention been given to the study of wood as a branch of applied science as at present. In the British Empire during the last twenty years special efforts have been made to utilise in greater degree and to better purpose the timber resources of the different countries, since, with the exception of Canada, an extensive import of "foreign" woods has been a marked feature of their trade. Subject to a jealous safeguarding of the forests, it is clearly desirable that so far as possible the timber needs of the community should be met from local sources or from countries within the Commonwealth. With this object in view, the primary need is a satisfactory knowledge of the woods. Useful information serving an immediate purpose can often be gained by empirical methods, and it is important, therefore, that the readiness with which such results may sometimes be obtained should not be allowed to obscure the additional necessity for the scientific investigation of the various problems. The first requirement is information regarding the anatomy of wood since timber has an organic structure and is not a homogeneous material; the ultimate need is full knowledge of the chemical and physical constitution of wood substance.

As regards the first desideratum the present work affords a notable contribution as affecting an important group of useful timbers and supplements the information with technical and commercial particulars. The book is the outcome of collaboration in preparing an account of the more important Indian woods intended to bring up to date and record all available information regarding their structure, qualities and uses, and thus render accessible in collected form the results of the investigations carried out at the Forest Research Institute, Dehra Dun, since its establishment in 1906. The work owes its origin to the need for a revision of the late Mr. J. S. Gamble's classic *Manual of Indian Timbers*, the second edition of which appeared in 1902; and it is no detriment to the present

work to recognise the great debt it owes to that author. Professor Brown spent two years (1923–1925) at Dehra Dun in an investigation of the microscopic structure of Indian timbers and, in planning the book, it was arranged that he should deal with the anatomical characters and identification of the timbers, while Mr. Pearson (now Sir Ralph Pearson), in virtue of his extensive experience as Forest Economist at Dehra Dun, should be responsible for subject-matter concerning their distribution, technical qualities, uses and supplies.

The authors have written, in sections distinguished by their initials, a full Introduction which forms a valuable complement to the text. The main features are an account by Mr. Pearson of the forests of India and a statement of the principles of wood structure by Professor Brown. Neither of these two sections could have been written by anyone having greater knowledge of his subject than the author concerned.

The main text affords a remarkable example of the results that can be achieved by a systematic marshalling of information for a carefully planned object. The aim has been to record all available information on the uses and qualities of some 300 Indian timbers in use and to provide photo-micrographs at low and high magnifications of their structure. Three classes of woods were considered for description, viz. (*a*) those for which the demand equals the supply (65 species), (*b*) timbers in fair demand with supplies exceeding market requirements (106 species), and (*c*) timbers available in large supplies for which there is little or no demand (140 species); a total of 320 timbers. comprising 173 genera referable to 53 families. These facts alone indicate the value of the book. The samples used in preparing the descriptions were chiefly "Gamble specimens" (including those used in writing the "Manual") available in the Museum of the Forest Research Institute and were backed in most cases by herbarium specimens. The material is therefore authentic, but is relatively restricted and precludes the study of the variation of structure within a single species.

The plan of the work is admirable and calls for special reference. The text is arranged according to botanical families, genera and species. The sequence followed for the families is that employed by Brandis in his *Indian Trees*, which is essentially the arrangement of the *Genera Plantarum* except that the Gymnosperms (Coniferae) are placed at the end of the series. Two further departures from Bentham and Hooker's arrangement appear in the present work, viz. (*a*) the Bixaceae have been included in

the Flacourtiaceae and the genus Homalium (Samydaceae) has also been placed in that family; and (*b*) the genus Chloroxylon has been transferred from the Meliaceae to the Rutaceae. Under the family are first given references concerned with the woods of the family as a whole and not only those occurring in India, followed by information as to the size, distribution and economic importance of the group. The gross features of the woods and their salient anatomical characteristics are then described, but it is pointed out that no one anatomical character can be regarded as diagnostic for the woods of a given family. The story develops in the description of the genus: after references to literature and a statement of the number and distribution of species in the genus as a whole, mention is made of the number of species occurring in the Indian flora and of those dealt with in the text. The physical and anatomical features of the wood are then described in more detailed and increasingly specific form than under the family. The practical feature of this section is the provision of two "keys" to the identification of the woods; the first is based on physical and macroscopic characters visible to the naked eye or with a lens of low magnification ($\times$ 10): the second depends on anatomical features requiring a compound microscope for determination. These keys are practical in design and should prove satisfactory in use.

The full story appears in the sections dealing with the species. After references to literature, the trade and vernacular names of the wood are given, the standard trade names adopted by the Government of India for official use being printed in heavy type. Habit and distribution are discussed in paragraphs illustrated by outline "distribution maps" on which the areas of occurrence of the species are indicated by cross hatching. These maps are a most interesting feature and reveal surprising facts of plant geography often within a single genus: notable examples are afforded by Dalbergia, Terminalia, Canarium, and Sterculia.

The difficult question of available supplies of the timber is dealt with on the basis of the annual actual yield for the species commonly on the market and of information regarding other species specially obtained from forest officers throughout the country. The figures quoted are stated to be "very conservative," and it is admitted that for the full commercial development of the forests further surveys are a necessity; nevertheless, in some cases the estimates will probably occasion surprise in this country.

The sections dealing with structure represent an

immense amount of most careful work and are illustrated by photo-micrographs of cross-sections of the timbers which form the outstanding feature of the book. Two such photographs, representing magnifications of 10 and 150 diameters respectively, accompany the description of each species and are of sizes ($3\frac{1}{2} \times 3\frac{1}{4}$ inches and $6 \times 4\frac{1}{2}$ inches) which render them of real practical use. The value of photo-micrographs on uniform scales throughout needs no emphasis. The corresponding text deals, in great detail admirably arranged, with the naked eye and microscopic characters, and concludes with a summary of structural features. So far as we are aware, available literature affords no such visual demonstration of variation in timber structure as is provided by the remarkable series of photographs which illustrate Professor Brown's work. A comparison of the photographs of *Cordia* spp. (zonate parenchyma and fibres), *Aquilaria Agallocha* and *Strychnos Nux-vomica* (inter-xylary phloem), *Murraya exotica* (discontinuous growth rings), *Fagraea fragrans* (tyloses), *Sterculia campanulata* (a light wood), *Xylia dolabriformis* (a heavy wood), *Quercus* spp. and *Dillenia* spp. (rays), to say nothing of the coniferous series, is an anatomical exercise in itself. There can be but one regret concerning the structural diagnosis, namely, the absence of photographs of longitudinal (and especially tangential) sections which are such valuable — almost necessary—aids to the full understanding of timber structure. The reasons for their omission are no doubt cost, and limitation of space.

In the sections on mechanical properties the results of strength tests carried out in recent years by Mr. L. N. Seaman at Dehra Dun, or by Mr. Pearson, are quoted wherever available. So far as possible the strength values of broad-leaved species are compared with those of Burma teak and those of coniferous woods with *Cedrus Deodara*. The accounts of the working qualities of the woods are valuable as recording the results of trials specially carried out in the workshops at Dehra Dun. The sections on uses deal with present and prospective applications of the woods, and reference is justly made to the work done in this connection in England by Mr. Alexander Howard. There are two appendices: one dealing with a classification of Indian timbers according to their uses, which is reminiscent of Professor Troup's *Indian Timbers and their Uses*; and Appendix II, which is a glossary of scientific terms used in the text. The bibliography is a valuable feature of the book and its wide character suggests that Balfour's *Indian Timber Trees, Timber and Fancy Woods,*

and Laslett's work might have been included. There are admirable indexes.

In working through these volumes it is a matter of continuous regret that their price (£5) must inevitably place them beyond the reach of many readers anxious to possess them.

THE EMPIRE FORESTRY HANDBOOK, 1933. Edited by W. A. Robertson, F.R.G.S. Published by the Empire Forestry Association, London (price 5s.)

The general scope of the Handbook, which is published annually, has been described in this BULLETIN in dealing with a previous issue (1931, **29**, 282). The present edition is planned on lines essentially similar to those of its predecessors and calls for no detailed account on this occasion: the handbook aims at presenting in condensed form essential particulars relating to the forests of the Empire, and may claim to accomplish its purpose. The list of Trade Names of Empire Timbers which forms one of the most practical and useful features of the volume has been revised and the use of different types in the index to the list facilitates reference. A new feature of the list is an Appendix containing a series of addresses of buildings in which Empire timbers have been used for construction work, which may be inspected by permission of the occupiers. The Appendix would be more readily understood if the significance of the index numbers and method of using them were more specifically explained. A new section giving a list of forestry societies and forestry periodicals of the Empire is a most useful feature. Sir John Stirling-Maxwell, Chairman of the Empire Forestry Association, opens his Preface to the Handbook with the following remarks: "This new edition of the Empire Forestry Handbook records one change which cannot be passed over in silence. The number of technically trained forest officers in the Empire, which was 1,600 in 1931, has now declined by more than a hundred. This serious reduction has no doubt been made in response to the urgent need for economy, but seeing that it synchronises with the effort initiated at Ottawa to develop imperial trade it may well be doubted whether it is wise. It is quite certain that the development of the trade in timber within the Empire has been seriously held back up to now by the need for more complete surveys and better arrangements for utilisation, and the reduction in the staff can only accentuate both these obstacles."

AN ECONOMIC GEOGRAPHY OF THE BRITISH EMPIRE OVERSEAS. By J. Innes Stewart, M.A., B.Sc. Pp. ix + 231, $8\frac{1}{2} \times 5\frac{1}{2}$. (London: Sir Isaac Pitman and Sons, Ltd., 1933.) Price *6s.*

This handy volume, intended principally for use in schools, may be described as a brief encyclopædia of British overseas countries. It is clear and concise, well arranged and printed, and should be very useful for its purpose. A few points might suitably be revised in a later edition: thus on p. 72 the incorrect colloquialism "the Barbadoes" is employed for the single island of Barbados; on p. 90 there is a sentence regarding the Sisal "imported" which is far from clear; whilst a phrase regarding Australia on p. 153, "a surprising number of her people live in the large cities," is repeated on the following page. These details are however only mentioned as indicating that this excellent book can be still further improved.

(1) THE GOLD COAST, 1931: (2) A BIBLIOGRAPHY OF THE GOLD COAST. By A. W. Cardinall, Chief Census Officer. Pp. (1) 265, (2) 384, $9\frac{3}{4} \times 6$. (Accra: Government Printer, 1932.) Price *12s. 6d.* each.

The first of these volumes is described on the title-page as "a Review of the conditions in the Gold Coast in 1931 as compared with those of 1921, based on figures and facts collected by the Chief Census Officer of 1931, together with a Historical, Ethnographical and Sociological Survey of the People of that Country." It is essentially a practical and very informative handbook to the Colony, the sections dealing with history and ethnography being specially interesting. A number of excellent coloured maps are provided. A foolscap volume of Appendices, containing comparative returns and general statistics of the 1931 Census, is issued separately (price *12s. 6d.*).

The Bibliography, issued as a companion volume to the above, contains an interesting introduction in which the author indicates the great trouble which he has taken to make the entries as complete and accurate as possible. The list consists of 5,168 items—commencing with a Latin treatise by the Portuguese writer Francisci de Amada, published in 1506—and is arranged in fifteen classified sections, six of which are chronological and the remainder of a specialised kind (Missions, Anthropological, Linguistic, Climate, Economic, etc.). The Economic section is the longest, and is arranged in 13 sub-divisions—Forestry, Geology, Fauna, Cacao, Palm Oil, Rubber, and so on. Blank pages are inserted at the end of the various sections

for manuscript addenda. This admirable compilation should become a standard work of reference.

THE BOOK OF BRITISH INDUSTRIES. Edited by Hugh J. Schronfield, with a foreword by Sir J. George Beharrell, D.S.O. Pp. 387, $8\frac{1}{2} \times 5\frac{1}{2}$. (London: Denis Archer, 1933.) Price 8*s*. 6*d*.

This extremely interesting and informative volume consists of forty-five chapters, each devoted to a particular industry and written by a prominent expert in the trade concerned. The subjects naturally cover a wide range, and it must suffice to say here that they are all described in a very readable way and that the editor is to be congratulated on the admirable results of his undertaking, which, as explained in his Introduction, was to produce a volume which would serve the layman as a well-informed guide to British industry.

WEST AFRICAN AGRICULTURE. By O. T. Faulkner, C.M.G., B.A., and J. R. Mackie, M.C., B.Sc. Pp viii + 168, $8\frac{3}{4} \times 5\frac{3}{4}$. (Cambridge: The University Press, 1933.) Price 8*s*. 6*d*.

As the authors point out in their introductory chapter, the accepted policy of the Governments of British West Africa is primarily the moral and material advancement of the natives of the country and not the promotion of European trade and the production of raw materials for the world's industries. The economics of native agriculture thus become the foundation of agricultural policy. Incidentally this may lead to the maximum production of industrial raw materials because if, for example, labour can be saved in the production of foodstuffs for local consumption it becomes available for production for export. In attempting to advance the welfare of the West African it is essential that the advice tendered should be sound with respect to the conditions under which he lives. Over large areas he does his own work and is not an employer of labour. His aim is to secure the maximum result from the minimum effort, and his test of the "soundness" of a suggested change in practice is whether the result of the method advocated will be not a greater yield per acre, but a greater yield for a normal day's work.

In Part I of the book, the control over agricultural practice exercised by the climate, soil and political economy is shown. The native farm is described, after which the authors discuss the important question of shifting

cultivation and the closely related subjects of green manuring and mixed farming.

The normal procedure in shifting cultivation is to clear a piece of (preferably forest) land, crop it for three or four years and then let it remain as a bush fallow for about five years. The extent to which this can be practised naturally depends on the demand for land, i.e. on the density of the population. Green manuring is often advocated as a means of keeping the land in continuous cultivation. On the acid, sandy soils of the Delta region, however, green manure crops do not thrive, and experiments show that the subsequent crops are not so good as those following a bush fallow. In other regions green manure crops do well, but then other factors come into play. Thus where the rainfall is light it is not possible to grow a green manure crop and a foodcrop in the same year, and the consequent reduction in food crops without extending the area under cultivation may be of dominant importance. It is unfortunate that no tropical legume, which yields an edible crop, has a heavy bushy growth and in any case if the green manure be turned in whilst young, the difficulty of seed supply arises. The result is that whilst good results can be obtained from green manuring in some districts, in others it is not a practical proposition.

An alternative method is the adoption of mixed farming in regions suitable for cattle. With two bullocks a man can farm ten to twelve acres, and obtain enough manure to secure better yields than by shifting cultivation, it having been found that such small dressings as one to two tons of pen manure per acre is sufficient.

Problems then arise as to the best type of plough, as not only efficiency but low capital and running cost have to be considered. Other questions are dealt with in a similar manner.

Part II is devoted to the chief crop plants of West Africa, and in particular to a discussion, on broad lines and from an economic point of view, of improvements which might be effected. With cocoa for the European market the main objective is improvement in quality, which raises such questions as co-operative fermentation, grading, etc. For the U.S.A. quality is not so important, as the cocoa is largely used for extraction of cocoa butter. With the oil palm, the selection and propagation of the good types and high yielders, and the adoption of better methods of oil extraction, are desirable. With some crops local transport comes into play as a determining factor. Reduction in its cost may permit the production of a low-price crop, such as

ground-nuts, in a district which otherwise might be restricted to attempting to produce cotton or ginger.

Enough has doubtless been said to indicate that this book will be of great value, not only to administrative and agricultural officers, missionaries, etc., in West Africa, but also to all those in many other parts of the tropics who are concerned with the welfare of an agricultural peasantry.

YEAR-BOOK OF AGRICULTURAL CO-OPERATION, 1933. Edited by The Horace Plunkett Foundation. Pp. x + 204, $8\frac{1}{2} \times 5\frac{1}{2}$. DIGEST OF CO-OPERATIVE LAW AT HOME AND ABROAD. By Margaret Digby. Pp. xxii + 304. (London: P. S. King & Son, Ltd., 1933.) Price of the volume, 12*s*. 6*d*.

These two publications are bound together in one volume, under the title of the former, but are separately paged. The Year-book itself contains a number of short articles by various contributors, summarising the present position of agricultural co-operation in the United Kingdom, the Dominions and certain other parts of the Empire, and various foreign countries; these are followed by a descriptive section entitled New Books and Surveys, and a Bibliography of agricultural co-operation covering 30 pages.

The admirable Digest of Co-operative Law compiled by Miss Digby, Research Assistant to the Horace Plunkett Foundation, occupies over half the volume. It deals with practically every country in the world where agricultural co-operation is of importance, and should prove of considerable utility to readers interested in the legal aspects of the movement.

FOOD AND THE PRINCIPLES OF DIETETICS. By Robert Hutchinson, M.D., F.R.C.P., and V. H. Mottram, M.A. Pp. xvi + 630, $8\frac{1}{2} \times 5\frac{1}{2}$. Seventh Edition. (London: Edward Arnold & Co., 1933.) Price 21*s*.

In preparing the new edition of this standard treatise, first published in 1900, Dr. Hutchinson has secured the co-operation of Mr. V. H. Mottram, Professor of Physiology at King's College, London, who has practically rewritten the first three chapters and has assisted in the revision of the whole book. In general scope and arrangement the work retains its original form, but it has been thoroughly brought up to date and new matter has been introduced into every section. The value of this indispensable work of reference has thus been considerably enhanced.

Rubber Latex. By Henry P. Stevens, M.A., Ph.D., F.I.C., and W. H. Stevens, A.R.C.Sc., A.I.C. Pp. 156, $8\frac{1}{2} \times 5\frac{1}{2}$. Second Edition. (London: The Rubber Growers' Association, Inc., 1933.)

For the second edition this small book has been extensively rewritten to bring the general information which it contains more up to date. During the four years which have elapsed since the first publication was made, a large amount of work has been carried out on rubber latex, as regards both its production and its industrial applications.

Of chief interest as far as production is concerned is Chapter III, which deals adequately with the processes now in use for concentrating latex. Amongst these may be mentioned centrifuging, evaporation, filtering and creaming, including the latest method of creaming by means of an electric potential.

Chapters VI and VII have been enlarged and include descriptions of technical processes which have only recently been developed. Full accounts are given of the manufacture of dipped goods from latex, which has largely displaced the older method of using rubber solution; the coating of metals with rubber by electro-deposition methods; the manufacture of sponge rubber for upholstery by the frothing of latex; and many other processes.

Chapter IX is devoted to a review of the patent literature, and occupies nearly half the book. Over 500 recent British patents are reviewed, which testifies to the growing importance attached to the use of latex.

This book cannot fail to be appreciated by anyone who is in any way interested in latex, either as a producer or as a potential user.

Transparentfolien (Cellophan, Transparit, Heliozell, Ultraphan usw.) By Dr. M. Halama. Pp. xvi + 292, $8\frac{3}{4} \times 5\frac{3}{4}$. (Berlin-Steglitz: Chemisch-technischer Verlag Dr. Bodenbender, 1932.) Price RM. 18.

During recent years the industry concerned with the manufacture of transparent leaves or sheets has undergone a remarkable development and has attained a position of considerable importance. Published information on the manufacture and uses of such materials has been restricted hitherto to a few meagre notices scattered through a most diverse literature. The author of this book therefore determined to compile, on the basis of his own experience and with the advice of experts, as complete and exhaustive a review of the subject as might be possible. In carrying out his task he has borne in mind the requirements of the

manufacturer, the user, the machinery-maker, the supplier of the raw material, the chemist, the engineer, the patent agent, the merchant and the man of science. By this means he has facilitated mutual recognition by these various interests of their individual needs and has thus rendered possible a greater co-operation between trade and industry.

After a general historical review, a description is given of the various kinds of transparent leaf, including those composed of viscose, cellulose acetate, cellulose nitrate and gelatin. The most important of the processes of manufacture are described in detail, with the aid of numerous illustrations. One chapter is devoted to the planning, erection and mechanical equipment of transparent leaf factories. Reference is made to the numerous patent specifications which have been published in relation to methods and machinery. Information is also provided regarding the processes involved in the after-treatment of the material, including printing and colouring, cutting, embossing, craping, waterproofing, etc. The properties and physical characters of transparent papers are recorded and their various applications are discussed. Particulars are given of the manufacturing firms engaged in the industry, with details of their capital, directorates and products. A list of trade marks is also supplied.

The book contains specimens of various kinds of transparent leaf, and is provided with useful indexes. It forms a much-needed addition to the technical literature.

Directory of Paper Makers of Great Britain and Ireland for 1933. Pp. 271, 10¼ × 7½. (London: Marchant Singer & Co., 1933.) Price 5s.

In the new issue of this useful directory the contents have been revised and brought up to date. Several new features have been added, including a special article by Mr. Vincent S. Smith on "Tariffs and the Paper Trade" and alphabetical lists of waste-paper merchants, paper stock dealers, rag merchants and China clay producers and merchants. The valuable character of the directory has thus been fully maintained.

Transactions of the Bose Research Institute, Calcutta. Vol. VII, 1931–32. Edited by Sir Jagadis Chunder Bose, M.A., D.Sc., LL.D., F.R.S., C.S.I., C.I.E. Pp. vi + 343, 8¾ × 5⅞. (London, New York and Toronto: Longmans, Green & Co., Ltd., 1933.) Price 25s.

The reaction felt from a first glance through this volume, namely, that Sir J. C. Bose had launched out into

entirely new lines of work, finds expression in the introductory chapter in which the editor explains that the present book differs from its predecessors in that it includes papers relating to zoology and anthropology. He further remarks that in view of the greatly extended scope of the investigations the title " Life Movements in Plants " which has hitherto served for volumes of the *Transactions of the Bose Research Institute* becomes inappropriate, and has accordingly been dropped.

The volume contains sixteen papers by some twelve authors who record researches on very diverse subjects. The study of the " Capture of Fish by Drugging a Stream " (Bose) is of special interest since it affords experimental evidence that the explanation of the catching of fish by " poisoning," resulting from the well-known practice of adding certain plant extracts to the stream waters, lies in the action of the extract in inducing inactivation of the respiratory mechanism, death of the fish being due to asphyxiation. The phenomenon was studied in relation to the capture of fish in the mill stream of Darjeeling by the Lepcha fishermen, who employ for making the extracts certain stems and barks (including *Derris elliptica* Benth., *Bassia butyracea* Roxb., and *Milletia piscidia* W. and A.), seeds and fruits (*Anamirta Cocculus* W. and A., *Diospyros montana* Roxb., *Randia dumetorum* Lamk., etc.), and the root of *Milletia pachycarpa* Benth. Another fish study (Sircar and N. N. Das) deals with the motor paralysis induced in the animals by the local application of salt. Researches by B. K. Dutt indicate the existence of definite channels of conduction for the transmission of excitatory impulses in the leaves of sensitive plants (Mimosa), and new results have been obtained in regard to the combined effects of direct and indirect stimulation. *Neptunia oleracea* has been the subject of experiments by S. C. Das, demonstrating that change of environment has a modifying effect upon the various manifestations of irritability. An account of the habits of fish-eating spiders of Bengal is given (Bhattacharjee, Vidyaratna), and further work on the proteolytic enzymes of *Carica Papaya* (Nag and Banerjee) is recorded. Other chemical investigations relate to the constitution of the oils of certain pulses, viz., *Cicer arietinum* and *Phaseolus radiatus*, by Banerjee.

A paper by P. C. Basu, working in the newly-founded Department of Anthropology and Racial Biology of the Institute, deals with Burmese crania. The Editor comments on the unique field offered by India for the systematic study of biological problems relating to man. The book concludes with an account of a research into the

radio-activity of the hot springs in the ancient seat of pilgrimage at Rajgir.

On the Fixation of Atmospheric Nitrogen by Bacteria Living Symbiotically in Root Nodules of Casuarina Equisetifolia. By R. N. Aldrich-Blake, M.A., Oxford Forestry Memoirs, Number 14, 1932. Pp. 20, $10\frac{3}{4} \times 7\frac{1}{2}$. (Oxford: The Clarendon Press; London: Mr. Humphrey Milford, Oxford University Press, 1932.) Price 3s. *6d.*

This memoir records the results of a very satisfactory piece of research. The presence of nodules on the roots of Casuarina appears to have been first recorded by Janse in 1896, working in Java. Barber in the course of his well-known studies of the spike disease of sandalwood (1903) found that *C. equisetifolia* was a favourite host for this semi-parasitic tree, and observed that the Casuarina roots were infected with "a parasite resembling that of the well-known alder root tubercle." Later, in 1911, Kamerling pointed out the similarity of the endophytic organisms to *Bacillus radicicola* of leguminous plants and suggested that these bacteria also might fix atmospheric nitrogen, though he did not put his views to experimental test. The first to demonstrate the fixation of nitrogen was Narasimhan who in 1918 secured the requisite evidence from culture fluids containing pure cultures of bacteria from nodules of *C. equisetifolia.* No infection experiments, however, appear to have been carried out by this worker. Confirmation of the results was published by McLuckie (1923) and Rao (also 1923). The first infection experiments were recorded by Chaudhuri in 1931, when the research under notice was almost completed. Sterile plants of *C. equisetifolia* potted in soil containing a pure culture of the symbiotic bacterium gave negative results, since no nodules were found at the end of three months when the experiment was concluded. A small proportion of other plants furnished with crushed nodules in the potting soil bore nodules, however, but showed no advantage as regards growth when compared with controls in sterile soil.

The present author's work on infection experiments was commenced in 1930 on the general assumption, based on the earlier researches, that all species of Casuarina have a nitrogen economy similar to that of leguminous plants; but with the conviction that it was desirable to strengthen the assumption by growing seedlings of at least one species with and without the symbiotic bacterium. Additional interest attached to the proposed investigation in its

relation to the work of the author and of Miss Reid regarding the influence of quantitative availability of nitrogen upon the size of the plant root system, in which it was shown that an increase of available nitrogen is accompanied by a decrease of relative root weight.

The work was carried out on *C. equisetifolia* at Dehra Dun with the assistance of Mr. H. G. Chapman and Mr. M. V. Laurie. The seedlings were sown in river sand rendered practically nitrogen-free and watered with a chemical nutrient solution free from nitrogen. Inoculation was effected by adding a quantity of crushed fresh nodules to the potting soil; uninoculated controls were carefully organised. As growth proceeded the height of all plants was measured, and the experiment was concluded in September 1931.

Not a single nodule was found on the roots of the control plants, while on those of infected plants nodules up to 3·8 cm. in diameter were numerous, especially in the upper layer of the soil. The height of the infected plants was markedly superior to that of the controls. As regards weight, the infected material at the end of the experiment was 50 times that of the controls without any nitrogen and seven times the weight of those receiving ammonium nitrate. It was found, moreover, that the nitrogen obtained through the bacteria from the inoculum reduced the root weight to a significant degree, the reduction being greater than that due to nitrogen derived from ammonium nitrate as supplied to the controls.

Thus the author's work proves that Casuarina may be added to the increasing list of plants which obtain atmospheric nitrogen through bacteria symbiotic in their roots or their leaves. Trees of this genus therefore are to be recommended as hosts for sandalwood tree and as soil improvers on sandy equatorial coasts. The author advises that wherever they have been introduced into the western tropics they should be furnished with their specific bacterium, which should be introduced in a crushed mixture of soil and nodules which could be forked into the seed bed or mixed with the seed.

An Introduction to Tropical Soils. By Dr. P. Vageler, translated by Dr. H. Greene. Pp. xvi + 240, $8\frac{3}{4} \times 5\frac{3}{4}$. (London: Macmillan & Co., Ltd., 1933.) Price 15s.

This book is the English translation of Dr. Vageler's "Grundriss der tropischen und subtropischen Bodenkunde," which has already been reviewed in this Bulletin (1931, **29**, 104).

The translation has been excellently done and should render the book available to a wider circle of readers, particularly planters and others interested in the practical aspects of tropical agriculture. The chapters on soil selection, choice of crops and soil management might profitably be studied by all those with any interests in such matters.

The translator has usefully included a few references to publications in English which are likely to be readily accessible and of value to the English-speaking reader.

Observations Géologiques dans la Partie Méridionale de L'Afrique Equatoriale Française. By Dr. V. Babet. Pp. viii + 154, 11 × 7½. (Paris : Larose, 1932.)

In 1929, the author of this work published the results of the first official reconnaissance of this part of French Equatorial Africa under the title "Etude géologique de la Zone du chemin de fer Congo-Océan et de la Région minière du Niari et du Djoué." Subsequently, field studies were extended to the north, in the region of the Lower Niari river, the Nyanga and the Upper Ogooué rivers. Instead of publishing the results of this last exploration separately, Dr. Babet has incorporated his original work, and thus he gives in one volume a general description of the physical geography, stratigraphy and economic geology of southern French Equatorial Africa.

The region as a whole forms a dissected peneplain with a general altitude of 1,600 to 2,000 feet, with no point higher than 2,700 feet. The Congo Valley at Stanley-Pool, on the border of the area with the Congo Belge, lies at about 900 feet. The major physiographic units are: (1) To the north, the Massif du Chaillu, composed of Archaean granite gneisses. (2) The Chaîne du Mayombe, running from north-west to south-east parallel to the coast and overlooking the littoral zone, composed of gneiss, mica-schists, chlorite-schists, sericite-schists, talc-schists and epidotites. (3) The Plateau des Cataractes in the south, separating the valley of the Niari from that of the Congo, and made up for the most part of the author's "Système Schisto-Gréseux." (4) The sandy Plateau Batéké to the north-east, separated from the Massif du Chaillu by the Upper Ogooué Valley, and marking the transgression of the Système du Loubilache (Karroo) across the older formations to the west. (5) Between the Massif du Chaillu and the Chaîne du Mayombe is a synclinal area composed of quartzites, phyllites, sandstones, limestones (including oolite), dolomites, etc., grouped into the

Système Quartzo-Schisteux, the Système Schisto-Calcaire, and the Système Schisto-Gréseux. For a large part of their course, the Niari and Nyanga and some of their tributaries flow along the strike of these beds, producing a series of parallel uplands and valleys.

Apart from the cephalopods, lamellibranchs and some vertebrate remains in the littoral zone (Cretaceous, Eocene and "Grés sublittoraux") which runs north-west and south-east of Pointe Noire, the only fossils found in the area are algal remains in beds of the Système Schisto-Calcaire. On general grounds, the author correlates the older formations with those of the Belgian Congo and of Angola. Above the "complexe cristallin et cristallophyllien," the Système Quartzo-Schisteux is considered to be equivalent to the Système Schisto-Dolomitique (with the Couches de Kibara) of the Katanga. The Système Schisto-Calcaire and the Système Schisto-Gréseux correspond to the Lower and Upper Kundelungu respectively; whilst the Système du Loubilache is equivalent to the Système du Loubilache et du Loualaba. It would appear that the author places the Systeme Schisto-Calcaire rather high in the sequence. It has usually been understood that the group Schisto-Dolomitique of the Katanga, including the Série des Mines and the Série Feldspathique, formed the lower part of the Système du Katanga, with the Kundelungu Series as the upper part. Fourmarier, however, makes the Serie Schisto-Calcaire of the Lower Congo equivalent to the Kundelungu of Katanga. Since the copper ores in this region occur in the Système Schisto-Calcaire, they must also be at a higher horizon than the other dolomitic copper ores of Africa, which are placed on the horizon of the Série des Mines of the Katanga.

With regard to Angola, the author correlates his Système Schisto-Gréseux with the Lui and Lombe beds of Angola, and through them with the Waterberg System of the Union. The Système Schisto-Calcaire is considered to be equivalent to the Bembe System and thus to the Transvaal-Nama.

At Otavi, the limestone-dolomite series has been referred to the Cambrian on the strength of traces of Archaeocyathidae: Cayeux, after an examination of the algal remains in the author's Système Schisto-Calcaire, refers them with reserve to the Silurian. The Transvaal system itself is generally considered to be Pre-Cambrian or Cambrian. Limestone-dolomite beds, often containing copper ores, are found throughout Southern Equatorial Africa, and since the Conference at Kigoma, have, with their associated beds, been referred to the Katanga

System, which ranges from the Série des Mines to the Upper Kundelungu, and is correlated with the Transvaal-Nama and Waterberg Systems.

The Witwatersrand and Ventersdorp Systems are considered to be represented by the Muva-Ankolean System, in which are placed such great groups of non-fossiliferous, probably Pre-Cambrian strata as the Karagwe Ankolean, the Muva, Ubinga and Mafindi Systems.

It is noteworthy that the African copper deposits are always found in rocks referred to the Katanga System, the Muva-Ankolean being characterised by tin deposits.

The stratigraphical position in Equatorial Africa is now becoming much clearer as a result of international action, and Dr. Babet's book marks an important stage in the process. In addition to detailed descriptions of the petrology of both the sedimentary and the igneous rocks, the economic minerals are listed and the occurrences described, in particular the copper ores exploited at Mindouli and Renéville. There are photo-micrographs of outstanding igneous rocks, of some oolites, and of fossil algae.

The book is illustrated by photographs which bring out well the dense tropical vegetation covering parts of the area, and there is a very excellent coloured geological map which merits special mention.

METAMORPHISM. A STUDY OF THE TRANSFORMATIONS OF ROCK-MASSES. By Alfred Harker, M.A., LL.D., F.R.S. Pp. ix + 360, 9 × 5¾. (London: Methuen & Co., Ltd., 1932.) Price 17*s.* 6*d.*

In this work the author claims to treat the subject from the genetic point of view, according to which, metamorphism comprises "a certain class of changes, which may affect rocks of any kind and alter their characters," without change in total composition during the process. Some authors, notably the Americans Van Hise and Leith, have in general adopted a wider view, including under metamorphism other processes of alteration. American geological work has been largely influenced by what Dr. Harker terms "economic and other extraneous considerations," and this is no doubt the reason why they have felt compelled to take this wider view of the meaning of the term metamorphism.

The book is divided into two parts, Thermal Metamorphism, and Dynamic and Regional Metamorphism. The presence or absence of important shearing stress is considered to be of "prime significance in determining the mineralogical changes which follow when rocks are sub-

jected to rise of temperature, and of capital importance also in relation to the setting-up of new structures." In each section, before dealing separately with the metamorphism of calcareous and non-calcareous sediments and of igneous rocks, Dr. Harker treats in detail the general considerations involved in each case, and the structures of thermally metamorphosed rocks and the crystalline schists. Special attention may be called to the very numerous and exceptionally clear drawings of minerals and textures in sections of specified rocks. The importance to the student of a clear drawing placed in contiguity with the appropriate text is obvious ; such a method, though arduous and exacting in its demands on the author, is in general much to be preferred to the practice of incorporating a few plates of photo-micrographs at the end of the text.

Dr. Harker has compressed into one comparatively small volume the results of wide experience in the study of British rocks. On the lines on which it is planned, made perfectly clear in the introduction, no sounder work on the subject can be imagined.

Treatise on Sedimentation. By William H. Twenhofel. Second Edition. Pp. xxix + 926, 9 × 6. (London : Baillière, Tindall & Cox, 1932.) Price 46*s*.

The first edition of Twenhofel's now well-known "Treatise" was reviewed in this Bulletin (1927, **25**, 206). The second edition preserves the plan of the first, the main chapter headings and general arrangements of material being the same. Whilst it has been brought up to date and contains much additional material, the second edition is slightly less bulky than was the original, due to the use of a thinner paper.

The principal additions to the text have been made in Chapter V, which deals with products of sedimentation. This section of 415 pages shows an increase of 136 pages, whilst the section next in importance, on "Structures, Textures and Colours of Sediments," has been amplified by 60 pages. In the notice of the first edition it was stated that petroleum received no mention in Chapter V, and that no consideration was given to gold or to sedimentary deposits containing important metals such as copper, lead, zinc and vanadium. The new edition contains a short section of about one page on "The Mother Rocks of Petroleum," but this is not included in the index. The sedimentary deposition of copper compounds, and the transformation and deposition of gold by surface waters, are briefly discussed in a section of three pages

(Miscellaneous Sedimentary Products) at the end of Chapter V. Lead and zinc also find brief mention here, although lead is not indexed. The transportation of gold and platinum by surface waters does not seem to have received the attention it deserves. It is now common knowledge that the coarseness of gold or platinum in alluvial deposits is not necessarily an indication that the grains are of similar coarseness in the original source.

The criticism made regarding the chapter in the first edition on field and laboratory studies, that it was too brief to be of much use, still applies, only 17 pages being devoted to this subject.

European, in addition to American, literature, seems to have been thoroughly searched for material for the new edition, and credit is given to British geologists for their pioneer work on the heavy minerals of sedimentary rocks, and the practical applications of this study. The thoroughness of the documentation is indicated by the fact that Chapter V alone contains 1,030 footnote references. In spite of this, the book is quite interesting to read consecutively, as continuity is well maintained.

This work of Twenhofel and his collaborators has proved its worth to all classes of geologists, and this edition gives a new lease of life to this outstanding and comprehensive book on an important subject.

ELEMENTS OF MINING. By George J. Young. Third Edition. Pp. xvii + 707, 9 × 6. (New York and London: McGraw-Hill Book Company, Inc., 1932.) Price 36*s*.

During the ten years that have elapsed since the publication of the previous edition of this well-known text-book, many changes have taken place in mining industries. These changes have, in general, brought about an increased efficiency in mining technique and a reduction in working costs. The author has consequently incorporated into the present work much new data that will be of interest both to the mining student and professional mining engineer.

Thus in Chapter I the section on the grade of ores has been largely rewritten, while a new table has been added giving dredging results for a number of years up to 1929 of Yuba Consolidated Gold Fields, California. Chapter II, on prospecting, has been enlarged by 19 pages on geophysics and aerial photography, and now contains an adequate survey of the magnetic, gravimetric, seismic and electrical methods of prospecting. Minor revisions have been made in the next five chapters on boring, drilling for

blasting purposes, rock breaking, blasting rock, and transportation and hoisting, while additional information regarding deep-well pumps and automatic pump control will be found in Chapter VIII on mine drainage.

Up-to-date information relating to air-conditioning and flood-lighting has been incorporated in Chapter IX. Chapters X and XI (79 pp.), devoted to the important subject of support of mine workings, contain new material on timbering and concreting. Chapter XII (44 pp.) gives a comprehensive account of modern methods of open-cast mining, and includes descriptions of drag-line and continuous bucket excavators among the fifteen different methods of excavation that are enumerated. The following Chapter XIII, on alluvial mining, remains essentially unaltered, as also do Chapters XVI–XIX dealing respectively with mine organisation and operation, mine accounting, accidents and miners' diseases, and examination of mineral deposits. Chapter XV, however, on underground methods, contains much new material on such subjects as the use of the scraper in top-slicing, mechanisation of coal mining, and South African stoping practice.

The book is excellently illustrated and undoubtedly maintains its position as one of the standard works on the elements of mining, especially in relation to American practice.

Elements of Mining. By Robert S. Lewis, E.M. Pp. v + 510, 9 × 6. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1933.) Price 31*s*.

This work, which is designed to present the fundamental principles of mining to the beginner of mining engineering, may be divided into three sections, as follows: (1) Chapter I (21 pp.), intended to give a brief exposition of the importance of mining in the commerce of the world; (2) Chapters II–XIII (pp. 22–468), concerned chiefly with engineering subjects; and (3) Chapters XIV–XV (pp. 469–495), dealing with the business side of mining. Each chapter is provided with a selected and up-to-date bibliography, so that the student can continue his studies in any branch of mining in which he may be particularly interested.

The introductory section, though brief, contains interesting observations on such subjects as mining as a basic industry, historical sketch of mining, national importance of mineral resources, and world production of gold, silver, copper, lead, zinc, iron, and mineral fuels. Much of the information regarding production has been abstracted from various Economic Papers of the United States

Bureau of Mines, and the following approximate data, taken from this source, are of particular interest:

Metal	Period.	World Production.
Gold	1492-1927	1,003,500,000 oz.
Silver	1493-1927	14,000,000,000 oz
Copper	1800-1927	40,000,000 tons
Lead	1800-1927	58,000,000 tons
Zinc	1800-1927	37,000,000 tons

Chapter II, on prospecting, is prefaced by a glossary of mining terms illustrated by a composite sketch. All the more important prospecting methods are enumerated, and special reference is made to geophysics. The following ten chapters deal with subsidence and the support of excavations, explosives, drilling and blasting, shafts, hoisting, mining methods, mine haulage, mine drainage and pumping, compressed air, and ventilation. The concluding chapters (Chapters XIV–XV) on (1) sampling and valuing mines, and (2) organisation, management and safety work, are especially well-written and informative.

In conclusion, the author has achieved a notable success in presenting so clearly so much important information regarding mining within the compass of a book of moderate dimensions.

Mine Examination and Valuation. By Charles H. Baxter and Roland D. Parks. Pp. xii + 316, 7½ × 5. (Michigan: Michigan College of Mining and Technology, 1933.) Price $3.00.

This book, which is of a handy size, is designed as the foundation for a course in Mine Examination and Valuation at the Michigan College of Mining and Technology. The authors assume that the intending student already has a knowledge of geology, mining methods and practice, principles of accounting and cost finding, and economics.

Part I, after a general discussion of the planning and preliminary phases of an examination, deals in detail with sampling methods and calculations. This is followed by chapters on ore estimation and capital assets other than ore. The final chapters of this section deal with the effect of general economic conditions on mine valuation, give a detailed graphical analysis of business conditions and discuss factors to be considered in estimating future costs and profits.

Part II, under the heading of Mine Valuation, discusses compound interest, annuities, amortisation of capital, mine valuation formulas for redemption annuities, perpetuities, and interest rates, and closes with an account of

the Morkill, Grimes-Craigue, and the O'Donahue modification of Hoskold's Mine Valuation formulas.

Part III consists entirely of tables, giving principal improvement and discount at compound interest, annuity improvement and discount at compound interest, present valuation of redemption annuities, and amortisation of invested capital.

The authors state in their foreword that " one of the outstanding jobs in mine valuation is the annual appraisal of the iron and copper mines of the State of Michigan for the purposes of taxation," and consequently Appendix A contains an account of the history, functions and operation of this appraisal by the Mining Engineer of the State of Michigan. Appendix B is a bibliography of 18 pages.

It should be noted that the authors do not confine their attention to developed mines, but also discuss the examination of prospects. The book is definitely American in outlook and will therefore be of less use to British engineers than might otherwise have been the case. British literature is given in the bibliography, but does not seem to have received much consideration in the compilation of the text.

Special Steels. A concise treatise on the Constitution, Manufacture, Working, Heat, Treatment and Applications of Alloy Steels for Students, Operators, and Users of Special Steels. Chiefly founded on the researches regarding alloy steels of Sir Robert Hadfield, Bt., and with a foreword by him. By T. H. Burnham, B.Sc., A.M.I.Mech.E., M.I.Mar.E. Pp. xviii + 233. $8\frac{1}{2} \times 5\frac{1}{2}$. Second Edition. (London: Sir Isaac Pitman & Sons, Ltd., 1933.) Price 12*s*. 6*d*.

The author, who has drawn freely on the researches of Sir Robert Hadfield, has condensed a wealth of information into this work, the first edition of which was published in 1923. Practically the whole field of alloy steels is covered, consideration being given more to the usefulness or importance of the steel rather than to any spectacular or interesting features it may possess. For this reason, the description of straight nickel, chromium, manganese and silicon steels and the manufacture of special steels occupies most of the book. Nickel-chromium steel is dealt with at some length, the author considering it to be " the best all-round alloy steel in commercial use." Other ternary steels, however, are somewhat summarily dismissed. Quaternary, complex steels, and in particular " high-speed " steels, are dealt with very briefly in a chapter of 16 pages.

The final chapter, entitled "Recent Development," gives the lines along which research is now proceeding with regard to hardness and hardening methods, examination by means of the spectroscope, X-rays, radium and the cinematograph, and new applications of special steels.

The book concludes with a classified list of papers, addresses, etc., which have been given by Sir Robert Hadfield, together with a short list of books on the metallurgy of steel.

The author has given a comprehensive yet concise review of current knowledge and practice in the manufacture of special steels which should prove of interest both to the technical and to the general reader.

Bituminous Emulsions for Use in Road Works. By F. Wilkinson, M.Inst.C.E., M.I.Mech.E., and F. J. Forty, B.Sc., A.M.Inst.C.E. Pp. 305, 8½ × 5½. (London: The Contractors' Record, Ltd., 1932.) Price 21s.

Modern industry has a facility for producing a constant stream of new materials, many of which the average man finds firmly established before he fully recognises their bearing on the improvement of the conditions in which he lives. Bituminous emulsions form a good case in point. They have risen so rapidly to the forefront of modern road-making that their uses and correct application have been (and still are, to some extent) subject to a certain amount of misunderstanding.

The present volume, by two practical civil engineers, represents a welcome attempt to describe the present position of bituminous emulsions in road construction.

In the first chapter the authors give an outline of the chemistry and physics of colloids and emulsions. This is naturally a somewhat difficult task to any but an expert colloid chemist, and the treatment is therefore brief and suffers from a few errors. The pure scientist may be inclined to criticise this chapter adversely, but the practical engineer will probably find the information sufficient for his requirements.

The next three chapters give an account of bitumen and other substances used in road work, and of the characteristics of emulsions and emulsifying agents.

Processes of manufacture of emulsions are described in Chapter V, and the authors have endeavoured to furnish the reader with authoritative and up-to-date information. It is to be regretted, however, that they have quoted patent specifications so extensively; in many cases without giving any indication whether the process described is one used industrially.

Chapter VI, dealing with "Tests for Bituminous Emulsions," draws attention to a number of essential properties of these emulsions and gives methods of testing. The British Standard Specification for asphaltic bitumen road emulsion is quoted at the end of this chapter.

The most useful part of the book is probably Chapter VII, which deals with the uses of bituminous emulsions. Here the authors speak with authority, and give the reader the benefit of their extensive experience, their aim throughout being to describe first-class practice in many different phases of road construction. The summary given on pp. 316 *et seq.* is in itself a valuable guide to the application of bitumen emulsions, and the importance of weather conditions is fully emphasised.

The concluding chapter deals with specifications and costs, and will be of particular interest to the engineer, manufacturer and contractor.

It is, perhaps, regrettable that no reference has been made to the utilisation of low-grade aggregates; to the surfacing of such areas as aerodromes and car-parks; and to the possible employment of bituminous emulsions in countries where severe extremes of climatic conditions occur. These considerations are, possibly, outside the scope of the present volume.

The authors are to be congratulated on producing a book which is, on the whole, clearly and accurately written, and should be of considerable service to all interested in road construction.

Lubricating and Allied Oils. A Handbook for Chemists, Engineers and Students. By Elliott A. Evans, F.C.S., M.I.P.T. Pp. xv + 175, $8\frac{3}{4} \times 5\frac{3}{4}$. Second Edition, Revised and Enlarged. (London: Chapman & Hall, Ltd., 1933.) Price 9s. 6*d.*

The first edition of this book was published in 1921 and was then reviewed in this Bulletin (1921, **19**, 263). In the twelve years which have elapsed since that time a considerable amount of research work has been carried out on lubrication and lubricants, and, in consequence of the incorporation of new matter, the book has increased from 128 to 175 pages.

The scope and arrangement of the book are the same as before and the chapter headings are unaltered except in the case of Chapter VII, which now deals with the decomposition of petroleum used as an engine lubricant, instead of only with its oxidation. This and other chapters have been much enlarged and brought up to date.

The position occupied by the author, as chief chemist

to Messrs. C. C. Wakefield & Co., should be sufficient evidence that the information he gives is reliable, and the book can be recommended to those interested in the testing and selection of lubricating oils.

INDUSTRIAL CHEMISTRY. A Manual for the Student and Manufacturer. Edited by Allen Rogers. 5th Edition. Vol. I, Inorganic; Vol. II, Organic. Pp. xxviii + 1,517, $9\frac{1}{2} \times 6\frac{1}{4}$. (London: Macmillan & Co., 1931.) Price 30*s*. per volume.

This useful work gives an account of the more important chemical industries, both inorganic and organic, with special reference to modern American methods and processes, each section being written by a specialist in the particular branch.

The wide range of subjects dealt with in the two volumes includes general manufacturing processes; fuel and water; the heavy acids; soda and allied industries; electrolytic industries; cement manufacture; ceramics; production of pigments; metallurgy of iron and steel; fertilisers; coal-tar and its distillation products; wood distillation; the petroleum industry; oils, fats and waxes; hydrogenation; essential oils; resins and gums; rubber; textiles; dyestuffs; leather; explosives; and brewing and malting.

In Chapter VII of Vol. I an attempt is made to summarise the methods of preparation and the properties of the elements and their principal industrial compounds. It is obvious that this could not be adequately effected in some thirty pages, and the section might well have been omitted, especially as the subject is so thoroughly dealt with in readily accessible text-books of chemistry. In other parts of the work there are occasional omissions which might perhaps be rectified in later editions. For example, under Zirconium, no mention is made of the use of the oxide as a refractory material or as an opacifier in enamels. The chapter on Lime, Cement and Plaster would be improved by including reference to high alumina cement, made from bauxite and lime. In the Clay, Brick and Pottery section the subject of refractories is rather inadequately treated. Some mention of helium might have been made in the chapter dealing with Industrial Gases in Vol. II.

Apart from such minor defects, however, the work is excellent. It should be very useful to those interested in the various branches of applied chemistry and can be recommended as a summary of modern practice in many

important industries. Its value is enhanced by the bibliography given at the end of each chapter.

Chemical Engineering and Chemical Catalogue. Edited by D. M. Newitt, Ph.D., B.Sc., D.I.C., A.R.C.S., A.I.C., A.I.Chem.E. Pp. lxxiii + 281, 10¾ × 8½. Ninth Edition. (London: Leonard Hill, Ltd., 1933.) Price 10s.

A notice of the 1932 issue of this useful annual publication appeared in this Bulletin (1932, **30**, 258), and its main features were briefly outlined. In place of the German-English vocabulary then mentioned, a corresponding Spanish-English vocabulary has been included in the new issue, and the general contents of the catalogue have been fully revised and brought up to date.

BOOKS RECEIVED FOR NOTICE

A Note-Book of Tropical Agriculture. Compiled by R. Cecil Wood, M.A., Dip. Agric. (Cantab.). Pp. 149, 6¾ × 4¼. (Trinidad, B.W.I.: The Imperial College of Agriculture, 1933.) Price 5s.

Second Annual Report on Cacao Research, 1932. By E. E. Cheesman, M.Sc., F. Hardy, M.A., F. J. Pound, E. E. Pyke, B.Sc., and J. A. McDonald, A.I.C.T.A. Pp. xii + 40, 11 × 8½. (Trinidad: Government Printing Office, 1933.) Price 5s.

Principles of Fruit Preservation. Jam Making, Canning and Drying. By T. N. Morris, M.A. Being Volume Six of a Series of Monographs on Applied Chemistry, under the Editorship of E. Howard Tripp, Ph.D. Pp. xiii + 239, 8¾ × 5½. (London: Chapman & Hall, Ltd., 1933.) Price 15s.

Dry Rot in Wood. By K. St. G. Cartwright, M.A., F.L.S., and W. P. K. Findlay, M.Sc., D.I.C. Second Edition. Department of Scientific and Industrial Research; Forest Products Research, Bulletin No. 1. Pp. vii + 34, 9½ × 6. (London: His Majesty's Stationery Office, 1933.) Price 1s.

Buch der Holznamen. I. A-Ca. By Dr. Hans Meyer. Pp. xviii + 108, 10 × 7. (Hanover: Verlag von M. & H. Schaper, 1933.) Price M.6.50.

Fertilizers and Crop Production. By Dr. Lucius L. Van Slyke, Ph.D. Pp. xiv + 493, 9×6. (New York: Orange Judd Publishing Company, Inc., 1932.) Price $4.00.

Secondary Aluminium (Metallurgy, Technology, Raw Materials, Production, Economics, and Utilization). By Robert J. Anderson, D.Sc. Pp. xv + 563, $9\frac{1}{4} \times 6\frac{1}{4}$. (Cleveland, Ohio: The Sherwood Press, Inc., 1931.) Price 42*s*.

The Genesis of the Diamond. By Alpheus F. Williams, B.Sc. Vol. I, pp. 1–352; Vol. II, pp. 353–636, $9\frac{3}{4} \times 7\frac{1}{4}$. (London: Ernest Benn, Ltd., 1932.) Price 84*s*.

Chemistry and Technology of Cracking. By A. N. Sachanen, D.Sc., and M. D. Tilicheyev. Translated by A. A. Boehtlingk, D. F. Brown and K. T. Steik. Pp. 389, 9×6. (New York: The Chemical Catalog Company, Inc., 1932.) Price $8.00.

Hydrogen Ion Concentration and its Practical Application. By Frank L. LaMott, William R. Kenny and Allen B. Reed. Pp. vii + 262, $9\frac{1}{2} \times 6\frac{1}{4}$. (London: Baillière, Tindall & Cox, 1932.) Price 20*s*.

An Introduction to the Calculus for Science Students. By G. Van Praagh, B.Sc., Ph.D. Pp. 92, $7\frac{1}{2} \times 5$. (London: Macmillan & Co., Ltd., 1933.) Price 2*s*. 6*d*.

REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

Selected from the Reports made to the Dominion, Colonial and Indian Governments

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TUNG SEED AND OIL FROM EMPIRE SOURCES (II)

REPORTS on samples of tung seed and oil from various parts of the Empire were published in this BULLETIN last year (1932, **30**, 271). Since then further samples, from India and Kenya, have been received and the results of their examination are given below. The previous report included the results of examination of the fruits and oil of *Aleurites montana* from China, for comparison with the seed of this species from Ceylon; the varnish trials with the Chinese oil referred to on p. 282 of that report are now completed and the results are included in the following pages. As a matter of interest to Empire growers of tung seed the results are also given of the examination of fruits of *Aleurites Fordii* grown at Misiones, Argentina, where, as stated in this BULLETIN (1932, **30**, 33), great activity is being shown in the planting of tung trees.

As in the case of the previous samples dealt with, most of them were submitted for examination to Dr. L. A. Jordan, Director of the Research Association of British Paint, Colour and Varnish Manufacturers, and a member of the Imperial Institute Sub-Committee on Tung Oil, in accordance with an arrangement whereby the Association is carrying out, on behalf of the Sub-Committee, comparative investigations of tung seeds and oil from different sources.

Aleurites Fordii Fruits from Bihar and Orissa, India

The sample, consisting of six fruits, was forwarded in September 1932 to the Imperial Institute by the Assam Frontier Tea Company Ltd., and was stated to have been grown on the Company's estate in Ranchi, Bihar and Orissa. Although the trials were only started on a very small scale in 1928, the trees have made extremely rapid growth and actually produced some seed in their third year.

The sample was examined at the Imperial Institute with the following results:

The fruits were of normal appearance, being dark brown and measuring $1\frac{3}{4}$ in. in both length and diameter. The nuts, which measured 0·9 in. in length and 0·75 in. in diameter, had reddish-brown or grey shells, which were rather smoother than is usually the case. They contained cream-coloured kernels of normal appearance.

The following table gives the results of the examination of the sample in detail:

Fruits		
Average weight	*grams*	19·5
Husk	*per cent*	42·7
Nuts	*per cent*	57·3
Average number of nuts in a fruit		4·5
Nuts		
Average weight	*grams*	2·5
Shell	*per cent.*	38·1
Kernel	*per cent*	61·9
Kernels		
Average weight	*grams*	1·5
Oil in kernels	*per cent.*	64·9
,, ,, expressed on entire nuts	*per cent.*	40·2
,, ,, expressed on entire fruits	*per cent.*	23·0

The oil had the following constants as determined by the methods prescribed in the British Standards Institution's specification for tung oil:

Refractive index at 20° C	1·5211
Iodine value (Wijs, 1 hour)	170·5
Heat test	10·5 minutes

The oil, as extracted from the kernels with light

petroleum, was of good pale colour. On polymerisation it produced a gel of satisfactory character.

The results of examination show that the tung fruits were of satisfactory composition and contained a normal percentage of oil. As far as could be determined from the small quantity available, the oil was of good quality and would be entirely suitable for all the purposes to which the tung oil of commerce is applied.

Aleurites Fordii Oil from Bihar and Orissa, India

A small sample of oil was received at the Imperial Institute in December 1932 from the Director, Indian Lac Research Institute, Ranchi, Bihar and Orissa. The oil, which was stated to be one year old, had been expressed from seed grown at Namkum and Sabaya, Ranchi District.

The sample had been examined in India in November 1931 and gave the following results:

Specific gravity at 15 5/15·5 C	0·9391
Acid number	0 2–0·3
Saponification number	192 3
Refractive index at 25° C	1·514
Iodine number (Wijs)	175·5
Heat test (A S T M)	10¾ minutes
Colour	Pale yellow

Aleurites Fordii Seeds from Kenya

Two samples of seed were forwarded in September 1932 to the Director, Royal Botanic Gardens, Kew, by the Conservator of Forests, Nairobi. They represented respectively the 1931 and 1032 crops from *Aleurites Fordii* trees growing in Nairobi.

The samples were submitted to Dr. L. A. Jordan, who has furnished the following report:

"The nuts arrived in a clean, dry condition, free from insects and pests. The physical examination gave the following results:

		1931.	1932.
Average weight of nut	*grams*	2·80	2·93
Nut consists of:			
Shell	*per cent*	41·2	37·5
Kernel	*per cent.*	58·8	62·5
Moisture	*per cent.*	6·3	6·4
Oil (solv. extr P.E. 60–80)	*per cent.*	35·3	36·3
Oil on dry decorticated kernel	*per cent.*	67·2	64·7

"The above figures would appear to accord with the average values observed for the species. Oil was expressed in the laboratory hydraulic press, and gave the following on examination:

	1931.	1932.
Colour—Lovibond (1 cm):		
Red	0·30	0·36
Yellow	1·0	1·4
Refractive index $n_D 25°$	1·5181	1·5181
Density (25° C.)	0·9361	0·9358
Heat test	12½ minutes	12½ minutes
Acid value	0·6	0·4
Iodine value	167·7	168·0
Saponification value	192·6	194·4

"The gel obtained in the heat test was of satisfactory texture.

"The two oils appear to be of satisfactory quality, with very little difference between them. The slightly higher acidity of the 1931 oil may be ascribed to the storage of the fruit, though the difference in colour runs counter to expectation on this basis."

Varnish Trials with Oil of *Aleurites montana* Fruits from China

In February 1932 a sample of *Aleurites montana* fruits, stated to have been obtained from China, was submitted to the Imperial Institute by the Director of Agriculture in Ceylon, and a report on the composition of the fruits and the characters of the oil was furnished by the Imperial Institute (see this Bulletin, *1932*, **30**, *280*).

The Director of Agriculture had requested that varnish-making trials might be made with the oil in comparison with that of *A. Fordii*, and these have been carried out by Dr. L. A. Jordan, who has now furnished the following report:

Report upon the Quality of Varnish Prepared from the Oil of Chinese Aleurites montana *Fruits*

"The test was carried out in fulfilment of a request from the Director of Agriculture in Ceylon in whose region *Aleurites montana* flourishes better than the Fordii species. The two oils are of the same general character, but that of *A. montana* possesses constants indicative of

a lower quality of material. These experiments were made upon oil expressed cold in the laboratory from seed obtained from China by the Director of Agriculture, Ceylon, and the characteristics of the oil so obtained have formed the subject of a previous report (August 1932).

" The results of the present tests must be interpreted with due reserve, since though a varnish was made from each of the oils by a comparable procedure the very nature of the process of manufacture introduces inconsistencies from which it is impossible to conduct an exact repetition. The only sure guide would be the experience of some hundreds of preparations.

" The materials used were :

(*a*) the montana oil already referred to ;
(*b*) the Fordii oil for comparison was an American high-grade oil comparable with those obtained by pressing samples of *A. Fordii* in the laboratory ;
(*c*) a standard commercial Pb-Co drier was added in proportions usual in varnish practice ;
(*d*) pure white spirit was employed for thinning.

" The varnishes for test were made up in a stainless steel pot heated by gas, and the procedure resembled as nearly as possible that employed upon large-scale work. The oil was heated to 240° C. in 35 minutes, and high-grade W.W. rosin equal to 50 per cent. by weight of the oil was stirred in. The temperature was then held at 240° C. for 90 minutes, and after cooling to 140° the varnish was thinned with white spirit and the driers added. The Fordii varnish bodied to a notably greater extent under this treatment, and required more thinner to yield a product of the same viscosity as that from montana oil.

" Owing to the greater proportion of volatile thinner in the Fordii varnish, the films submitted to weathering tests would be of slightly less thickness than those of the montana varnish.

" Both the resultant varnishes were pale and clear, brushed satisfactorily and dried in a normal manner.

" Panels were prepared for test in the open and by artificial weathering. For the open-air test, monel metal panels were brushed and exposed for nine months at

45° to the horizon facing south. For artificial weathering, panels were prepared on:

(*a*) mild steel primed with a lead chrome paint.
(*b*) monel metal.
(*c*) Parkerised mild steel.
(*d*) Bonderised mild steel.

" They were submitted to a standard cycle of treatment made up as follows:

Monday–Saturday

2 hours in refrigerator at 21° F.
21 hours exposed to two electric arcs in vita glass; sprayed with water for 2 minutes every 20 minutes, and the air in the tank at approximately 110° F and 50 per cent relative humidity.
1 hour inspection and change of carbons

24 hours

Sundays.

23 hours exposed to arcs
1 hour changing of carbons

24 hours

" The artificial weathering was carried on to 3,005 hours.

"*Results.*—The natural weathering, during the period of nine months from September 1932, showed little difference between the two varnishes. The only breakdown consisted of elongated cracks through which the bare metal was distinguishable. The montana varnish showed rather fewer cracks per unit area of the panel, but these cracks were perceptibly wider than those on the panel coated with Fordii varnish.

" In the case of artificial weathering, cracking was again the only failure, and the following table gives the hours of exposure leading to breakdown in each case:

	Chromed mild steel.	Monel metal.	Parkerised mild steel.	Bonderised mild steel.
	hours.	*hours.*	*hours*	*hours.*
Montana	<u>2032</u>	<u>1828</u>	1413	<u>1650</u>
Fordii	2010	1690	<u>1482</u>	1413

" The better figure is underlined in each case.

" It will be seen that there is a slight bias in favour of the montana varnish on durability grounds, but this is offset by the less thinning it received in preparation; the differences observed throughout are within the limits

of variation which might be observed in two varnishes made from the same materials."

In a subsequent communication Dr. Jordan points out that although the foregoing report is quite favourable to the use of montana oil in varnishes, nevertheless this oil would be at a discount in comparison with Fordii oil for the reason that the former oil will not fulfil the requirements of the British and other standard specifications for commercial tung oil as regards specific gravity, refractive index and the heat test. He added that a small proportion of adulterant added to Fordii oil will give a product with the general characteristics of montana oil.

Aleurites Fordii Fruits Grown at Misiones, Argentina

This sample was received at the Royal Botanic Gardens, Kew, and forwarded to Dr. L. A. Jordan, who has submitted the following report :

" The large sample of 60 kilos. was quartered and a small sample obtained. The fruits were of good average weight, and showed a satisfactory overall oil content. Some maggots were found in the course of opening the fruits, but it was observed that in no case did they penetrate to the kernel of the fruit.

" The oil obtained was of satisfactory colour and acidity ; as has been observed several times before, being from the first crop of fruit borne by the trees, its content of more saturated glycerides was higher than normal, resulting in a somewhat low refractive index, and slightly long gelation time.

Fruit

Average weight of whole fruit	*grams*	31·2
Average number of nuts per fruit	*grams*	4·7
Average weight of nut	*grams*	3·63
Whole fruit consists of :-		
Nut	*per cent*	55·3
Husk	*per cent.*	44·7
Nut consists of		
Kernel	*per cent*	61·9
Shell	*per cent*	38·1
Moisture	*per cent.*	9·0
Oil	*per cent*	33·7
Oil, on dry decorticated kernel	*per cent*	63·7
Oil, on whole fruit	*per cent*	18·6

	Oil Cold pressed from sample.	First-class *Fordii* oil.	First crop (India).
Colour (Lovibond 1 cm):			
Red	0·24	0·36	—
Yellow	1·2	1·85	—
Acid value	0·37	0·58	—
Iodine value	167·0	167·1	168·6
Heat test	11·5 min.	10·0 min.	12·2 min.
Refractive index $n_D 25°$	1·5178	1·5196	1·5177
Density 25/4	0·9334	0·9346	0·9333

Dr. Jordan has also furnished the following report on the varnish capabilities of the oil expressed from the fruits of *Aleurites Fordii* grown in the Argentine:

"The properties of the oil are characteristic of the species. The slightly low refractive index and prolonged gelation time accord with the idea that the fruit came from young trees or a cool climate.

"Varnish-making trials on small samples of oil present a number of very special difficulties, more particularly when comparison is called for with some other material, because each material needs a specific treatment to enable it to give the best results, while, if strict comparison is asked for, the two materials will receive identical treatment, and one at least will then be performing under unsuitable conditions.

"Thus, with an oil of the present type, the slightly lengthened gelation period will result in relatively slow bodying in the varnish pot, and in comparison with a representative oil cooked under identical conditions, will yield too thin a product. This may be rectified, for the purpose of brushing-out tests, by adding a smaller quantity of thinning solvent, but the result thereof is to increase the thickness of the dry film, which is certain to modify its weathering properties in comparison with the more diluted material.

"In view of these considerations, it is entirely unwise to pass any final judgment upon the behaviour of a few small batches of material: the present oil, however, appears to be perfectly normal in all important respects."

SHEA KERNELS FROM NIGERIA

The seventeen samples of Shea kernels which are the subject of this report were forwarded to the Imperial Institute by the Director of Forests in September 1932.

The samples were collected, at the suggestion of the Imperial Institute, for examination in continuation of previous investigations of Shea nuts as a result of which certain provisional conclusions had been arrived at as to the relation between the yield of oil from the kernels, the amount of unsaponifiable matter in the oil, and the degree of ripeness of the nuts (see this BULLETIN, 1930, **28**, 123, and 1931, **29**, 407, where two other series from Nigeria are dealt with; and 1932, **30**, 282, which deals with samples from the Gold Coast). With a view to obtaining further evidence on these relationships it was suggested that series of samples of kernels should be collected from individual trees at different stages in the transition from immature fruits to fully ripe fruits, and also from ripe fruits which had fallen from the tree and lain for varying periods on the ground.

Seven of the samples were obtained from one tree and seven others from a second tree, both situated at a point about 7 miles N.E. of Zaria Township. It was stated that there were a fair number of Shea trees in the vicinity but that many of them had few or no fruits, whereas the two selected trees were well fruited.

Fruits were collected from each tree on seven occasions, at intervals of a week, the kernels being removed at the time of collection and their weight carefully noted. The eighth collection would have represented the mature fruits, but unfortunately these fruits were removed from the trees by natives so that in each series the final sample is missing. A supply of mature fruits was, however, obtained from other trees and three samples of kernels were extracted from these on the 4th, 14th and 28th days after picking. The fruits used for the two latter samples had been allowed to lie on the ground.

On the conclusion of the series of experiments, which extended over three months, the various samples of kernels were forwarded in their entirety to the Imperial Institute for comparative examination.

Results of Examination

(1) The dimensions and appearance of the kernels as received at the Imperial Institute are given in the following table, the date of collection being stated in each case :

Tree No 1.—Kernels collected at intervals of a week to represent stages in the transition from immature to ripe fruits

Sample	Date of collection and weighing	Characters			Remarks
		Dimensions in inches	External colour	Internal colour	
1	22.4.32	0·7 long by 0·3 diameter to 1·2 long by 0·6 diameter, mostly 1·0 long by 0·5 diameter	Reddish-brown to dark reddish-brown	Pale pinkish brown	Mostly rather shrivelled
2	29.4.32	0·8 long by 0·5 diameter to 1·1 long by 0·75 diameter, mostly 1·0 long by 0·7 diameter	Reddish brown to dark reddish-brown	Pinkish brown	Some rather shrivelled
3	6.5.32	0·9 long by 0·5 diameter to 1·2 long by 0·8 diameter, mostly 1·1 long by 0·7 diameter	Very dark reddish brown	Pale pinkish-brown to pinkish brown	A few rather shrivelled
4	13.5.32	1·0 long by 0·6 diameter to 1·3 long by 0·8 diameter, mostly 1·1 long by 0·7 diameter	Very dark reddish brown	Pinkish-brown	A few rather shrivelled
5	20.5.32	1·0 long by 0·6 diameter to 1·3 long by 0·8 diameter, mostly 1·2 long by 0·75 diameter	Reddish-brown to very dark reddish-brown	Pinkish-brown to chocolate brown	A few rather shrivelled
6	27.5.32	1·0 long by 0·6 diameter to 1·6 long by 0·8 diameter, mostly 1·3 long by 0·75 diameter	Reddish-brown to very dark reddish-brown	Pale pinkish-brown to chocolate brown	A few rather shrivelled
7	2.6.32	1·0 long by 0·7 diameter to 1·4 long by 0·9 diameter, mostly 1·3 long by 0·8 diameter	Dark reddish-brown	Pale pinkish-brown to pinkish-brown	—

Tree No 2.—Kernels collected at intervals of a week to represent stages in the transition from immature to ripe fruits

Sample.	Date of collection and weighing	Characters			Remarks.
		Dimensions in inches	External colour	Internal colour	
1	22. 4. 32	1·0 long by 0·4 diameter to 1·5 long by 0·5 diameter, mostly 1·3 long by 0·5 diameter	Reddish brown to dark reddish-brown	Pinkish brown	Mostly rather shrivelled
2	29. 4. 32	1·0 long by 0·4 diameter to 1·5 long by 0·7 diameter mostly 1·4 long by 0·6 diameter	Very dark reddish brown	Pale pinkish brown to chocolate brown	A few rather shrivelled
3	6. 5. 32	1·1 long by 0·4 diameter to 1·6 long by 0·8 diameter mostly 1·4 long by 0·7 diameter	Dark reddish brown to very dark reddish brown	Pinkish brown to chocolate brown	Some rather shrivelled
4	13. 5. 32	1·0 long by 0·5 diameter to 1·6 long by 0·8 diameter, mostly 1·4 long by 0·7 diameter	Pale reddish brown to very dark reddish brown	Pale pinkish brown to chocolate brown	Some rather shrivelled
5	20. 5. 32	1·0 long by 0·6 diameter to 1·6 long by 0·8 diameter, mostly 1·4 long by 0·7 diameter	Pale reddish brown to very dark reddish brown	Pale pinkish brown to chocolate brown	—
6	27. 5. 32	1·2 long by 0·6 diameter to 1·7 long by 0·75 diameter, mostly 1·4 long by 0·7 diameter	Pale reddish brown to very dark reddish brown	Pale pinkish brown to chocolate brown	—
7	2. 6. 32	1·0 long by 0·4 diameter to 1·6 long by 0·8 diameter mostly 1·4 long by 0·7 diameter	Reddish brown to very dark reddish brown	Pinkish brown	—

Other Trees.—Kernels from ripe fruits.[1]

Sample	Date of collection and weighing of kernels	Characters		
		Dimensions in inches	External colour	Internal colour
8	17.6.32	1·0 long by 0·7 diameter to 1·5 long by 0·8 diameter; mostly 1·3 long by 0·8 diameter	Pale reddish brown to very dark reddish brown	Pale pinkish-brown to pinkish-brown
9	28.6.32	1·1 long by 0·6 diameter to 1·6 long by 0·8 diameter; mostly 1·3 long by 0·5 diameter	Pale reddish brown to very dark reddish brown	Pale pinkish-brown to pinkish-brown
10	12.7.32	0·8 long by 0·5 diameter to 1·5 long by 0·9 diameter; mostly 1·3 long by 0·8 diameter	Reddish brown	Pale pinkish-brown to chocolate brown

[1] *Samples 8–10 were derived from the same supply of ripe fruits which were picked on 14.6.32. In the case of samples 9 and 10 the fruits were allowed to lie on the ground prior to the extraction of the kernels.*

(2) The following table gives the date of collection of each sample, its weight and the average weight of the kernels at the time of collection, and also the weight of the sample and average weight of the kernels after arrival at the Imperial Institute:

Tree No 1.—Kernels collected at intervals of a week to represent stages in the transition from immature to ripe fruits

Sample	Date of collection and weighing in Nigeria	Weight of fresh kernels in Nigeria	Average weight of fresh kernels in Nigeria	Weight of kernels as received at the Imperial Institute	Average weight of kernels as received at the Imperial Institute
		Grams	*Grams*	*Grams*	*Grams*
1	22 4 32	432	11 1	78	2 0
2	29 4 32	1 042	13 7	243	3 2
3	6 5 32	1 053	13 2	326	4 1
4	13 5 32	1 099	14 7	361	4 8
5	20 5 32	1 226	14 6	465	5 5
6	27 5 32	1 102	13 9	499	6 3
7	2 6 32	1 175	14 5	520	6 4

Tree No 2.—Kernels collected at intervals of a week to represent stages in the transition from immature to ripe fruits

Sample	Date of collection and weighing in Nigeria	Weight of fresh kernels in Nigeria	Average weight of fresh kernels in Nigeria	Weight of kernels as received at the Imperial Institute	Average weight of kernels as received at the Imperial Institute
		Grams	*Grams*	*Grams*	*Grams*
1	22 4 32	514	12 5	129	3 1
2	29 4 32	1 086	14 1	282	3 7
3	6 5 32	1 054	13 3	371	4 7
4	13 5 32	993	12 6	390	4 9
5	20 5 32	1 136	14 0	470	5 8
6	27 5 32	1 149	14 2	495	6 1
7	2 6 32	1 091	14 1	501	6 4

Other Trees.—Kernels from ripe fruits

Sample	Date of collection and weighing in Nigeria	Weight of fresh kernels in Nigeria	Average weight of fresh kernels in Nigeria	Weight of kernels as received at the Imperial Institute	Average weight of kernels as received at the Imperial Institute
		Grams	*Grams*	*Grams*	*Grams*
8	17 6 32	1 088	15 1	505	7 0
9	28 6 32	1 020	15 5	462	7 0
10	12 7 32	1 045	13 6	492	6 4

(3) The kernels were chemically examined with the following results:

Tree No 1.—Kernels collected at intervals of a week to represent stages in the transition from immature to ripe fruits

Sample	Moisture in kernels as received at the Imperial Institute	Oil in kernels as received at the Imperial Institute	Oil calculated on moisture free kernels	Unsaponifiable matter in oil	Unsaponifiable matter calculated on fresh kernels [1]
	Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent.*
1	11·3	13·8	15·6	40·3	1·00
2	9·3	21·6	23·8	22·6	1·14
3	8·0	31·5	34·2	14·7	1·43
4	7·8	35·7	38·7	10·9	1·28
5	7·5	41·5	44·9	7·7	1·21
6	6·9	42·0	45·1	6·5	1·24
7	6·7	44·4	47·6	6·2	1·22

Tree No 2.—Kernels collected at intervals of a week to represent stages in the transition from immature to ripe fruits

Sample	Moisture in kernels as received at the Imperial Institute	Oil in kernels as received at the Imperial Institute	Oil calculated on moisture free kernels	Unsaponifiable matter in oil	Unsaponifiable matter calculated on fresh kernels [1]
	Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*
1	9·1	21·3	23·4	16·7	0·89
2	8·8	25·5	28·0	11·9	0·79
3	7·8	35·7	38·7	8·1	1·02
4	8·1	31·9	34·7	8·8	1·10
5	7·4	40·4	43·6	6·1	1·02
6	7·0	42·8	46·0	4·8	0·88
7	6·7	45·1	48·7	4·6	0·95

Other Trees.—Kernels from ripe fruits

Sample	Moisture in kernels as received at the Imperial Institute	Oil in kernels as received at the Imperial Institute	Oil calculated on moisture free kernels	Unsaponifiable matter in oil	Unsaponifiable matter calculated on fresh kernels [1]
	Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*
8	6·7	43·2	46·3	6·1	1·22
9	7·2	42·3	45·6	6·1	1·17
10	6·7	47·1	50·5	6·7	1·49

[1] *i.e. calculated on the weight of the kernels recorded in Nigeria*

Remarks

The results of the present investigation indicate that:

(1) The percentage of oil increases as the kernel ripens.

(2) The percentage of unsaponifiable matter expressed on the oil decreases as the kernel ripens.

(3) The percentage of unsaponifiable matter expressed on the fresh kernels remains more or less constant throughout the period of ripening.

(4) The percentage of unsaponifiable matter expressed on the oil remains practically constant once the kernels have reached maturity.

(5) The oil from the kernels, for each specified date of collection, contained more unsaponifiable matter in the case of Tree No. 1 than in the case of Tree No. 2.

(6) The lower the oil content of the kernels the higher the percentage of unsaponifiable matter in the oil.

The results of previous investigations of two series of samples of Shea nuts from Nigeria suggested that (1) there is some relationship between the amount of unsaponifiable matter and the percentage of oil in the moisture-free kernels; the lower the oil content, the higher the percentage of the unsaponifiable constituent; and (2) that the riper the nuts, the lower the amount of unsaponifiable matter in the extracted oil.

When these results were considered by the Imperial Institute Committee on Oils and Oilseeds it was suggested as a possible explanation of this relationship that the unsaponifiable constituent is present in the nuts at an early stage of their development before the formation of the oil begins; that it remains more or less constant in amount during the secretion of the oil; and that consequently as the seed ripens the percentage of unsaponifiable matter in the oil falls proportionately as the oil content increases. It was pointed out that this explanation had been found to hold good as regards the formation of the pericarp oil of palm fruits and that it might also apply to Shea nuts.

It will be seen that the results recorded in the present report are in agreement with these suggestions.

GINGER FROM NIGERIA (II)

REFERENCE was made in this BULLETIN (1931, **29**, 34) to the efforts which are being directed by the Department of Agriculture, Nigeria, towards improving the quality of the ginger produced in that country, and the reports therein published on samples received up to that time showed that satisfactory progress was being made. Since

then supplies of ginger have been received at the Imperial Institute from the Department each year, some of the material representing commercial consignments and some being samples produced experimentally. Reports on this later material are given in the following pages.

1. Consignments Received in 1931

The consignments of ginger which are the subject of this report were forwarded in March and May 1931.

The first consignment consisted of about 10 tons and the second of about 5 tons of ginger, the latter representing three grades.

Representative samples drawn from the consignments were found to have the following characteristics.

10-*ton lot.*—This material consisted of unbleached, peeled ginger, in good clean condition. It was in the form of pieces and hands measuring up to 3¼ in. in length; the material was plump and fairly bold, well scraped, of pale buff colour externally and very pale straw-yellow within, soft when cut, and showing a short and slightly fibrous fracture. The pungency, aroma and flavour were good, and the material compared favourably with commercial samples of No. 3 Jamaica ginger.

The ginger was of better appearance, bolder, softer and of paler colour than the best material (Grade I) in the consignment from Zaria dealt with in Imperial Institute report of August 27, 1929 (this Bulletin, 1931, **29**, 35), and also than the consignment from the Oyo Province which was the subject of the report dated November 15, 1929 (*loc. cit.*, p. 38). It was not so bold or pale as the Grade I ginger from Southern Zaria dealt with in Imperial Institute report of November 29, 1930 (*loc. cit.*, p. 36), but was bolder (though slightly darker) than the Grade II ginger received at the same time as the latter.

5-*ton lot.*—Three grades of ginger were included in this consignment, viz. 6 cwt. of Grade I, 15 cwt. of Grade II and about 4 tons of Grade III. The different grades consisted of unbleached peeled ginger in good clean condition and possessed the following general characters:

Grade I.—Small pieces and hands measuring up to 2½ in. in length, buff-coloured externally and of a very pale straw-yellow tint within. The ginger was fairly plump and well scraped, fairly soft, short and slightly fibrous in fracture.

Grade II.—Hands measuring up to 3 in. in length, together with a few small pieces. The hands were of pale buff colour externally and of a very pale straw-yellow tint within. They were plump, well scraped and soft, and had a short fracture which was slightly more fibrous than that of Grade I.

Grade III.—Small pieces and hands measuring up to 3½ in. in length, the proportion of small pieces being less than in the case of Grade I. The ginger was similar in colour to Grade I, but rather plumper; it was well scraped, soft, and showed a short and slightly fibrous fracture.

The three grades were all of good flavour, aroma and pungency, and in general of a quality comparable with No. 3 Jamaica ginger; the best sample was Grade II, which was bolder and of better colour than the others. None of the grades was of quite such good quality as the "Special Grade" ginger from Southern Zaria dealt with in Imperial Institute report of November 29, 1930, and described as corresponding to "good bold Jamaica" (*loc. cit.*, p. 37), but were all superior to Grade III in the set of samples then examined.

The consignments were placed for sale in the hands of a firm of merchants in London, who valued the 10-ton lot at the same price as ordinary Jamaica ginger, which was currently realising 37*s.* 6*d.* per cwt. in London. They also regarded Grades I and III from the 5-ton lot as of about the same value as the latter, but considered Grade II to be worth nominally at least 5*s.* per cwt. more although the quantity of only 16 cwt. available was not sufficient for it to be offered as a separate lot.

Owing to a subsequent fall in the value of Jamaica ginger, it was not possible to obtain the price mentioned above, but both consignments were disposed of in October 1931 at 36*s.* per cwt.

2. Representative Grades of the 1931–32 Crop

The four samples of ginger which are the subject of this report were forwarded in March 1932. They were stated to represent grades of the 1931–32 crop.

The samples weighed from 1¼ to 2½ lb. each and were as follows:

Special Grade.—Unbleached peeled ginger, well scraped and in good clean condition; mostly in the form of large hands up to 4 in. long. The colour externally varied from very pale buff to pale brownish-white; internally, it was very pale straw-yellow. The ginger was bold, plump and fairly soft; short and slightly fibrous in fracture, and of good aroma, flavour and pungency.

Grade I.—Unbleached peeled ginger, well scraped and in good clean condition; mostly in hands up to 4 in. long. The ginger was pale buff externally, being on the whole of rather better colour than the foregoing sample of Special Grade. Internally it was very pale straw-yellow. It was mostly fairly plump, but less so than the Special Grade. The ginger was fairly soft, of short and slightly fibrous fracture, and of good aroma, flavour and pungency.

Grade II.—Unbleached peeled ginger, well scraped and in good clean condition; in small pieces and hands up to 4 in. long. The ginger was yellower externally than the above sample of Grade I; internally it was very pale straw-yellow to cream. It was mostly fairly plump. The ginger was fairly soft; short and slightly fibrous in fracture, and of good aroma, flavour and pungency.

Grade III.—Unbleached peeled ginger in good clean condition, in small pieces and hands up to 3 in. long. The material had been insufficiently scraped and was rather browner externally than Grade I, but internally it was very pale straw-yellow. The ginger was mostly fairly plump, but many pieces were lacking in plumpness. It was fairly soft, of short and slightly fibrous fracture, and of good aroma, flavour and pungency.

The following observations may be made regarding these samples in comparison with the graded Nigerian gingers received at the Imperial Institute in 1930 and 1931.

Special Grade.—As compared with the Special Grade dealt with in Imperial Institute report of November 29, 1930, which was stated to represent "a very distinct improvement on any ginger hitherto produced in Nigeria" (*loc. cit.*, p. 37), the present sample of this grade is bolder and of better colour, although not quite so soft when cut.

Grade I.—This ginger is bolder and of better colour than the sample of Grade II in the 5-ton lot of ginger dealt with above (p. 343), which was the best of the three grades in the consignment. The present sample is, however, not quite so soft as this earlier material.

Grade II.—This ginger is of slightly better colour and very slightly bolder than the previous sample of Grade II mentioned above, but not quite so soft.

Grade III.—This ginger is not so good as the sample of Grade II dealt with in the preceding report. It more closely resembles Grade I in the same 5-ton shipment, but is bolder and of rather better colour although not so soft.

The present samples indicate that as regards both boldness and colour the 1931–32 crop was in general considerably better than any of the previous crops from which samples have been sent to the Imperial Institute.

The merchants in London who disposed of the consignments sold in 1931 were consulted regarding the present samples, and furnished the following valuations (June 1932):

Special Grade.—65*s.* to 70*s.* per cwt. landed London, with Bold Jamaica at 90*s.*

Grade I.—60*s.* per cwt. with Jamaica No. 3 at 52*s.* 6*d.*

Grade II.—About 55*s.* per cwt.

Grade III.—About 50*s.* per cwt.

3. Samples Received in 1933

Fifteen samples of ginger were forwarded for examination and valuation in March 1933. They comprised the following groups:

Nos. 1, 2 *and* 3.—Standard grades I, II and III.

Nos. 4, 5 *and* 6.—Blue Ginger, grades I, II and III.

Nos. 1A–4A *and* 1B–4B.—Ginger from selected and ordinary seed.

Sample C.—Canton ginger grown at Maigana.

Samples 1, 2 and 3.—Standard Grades

These samples represented Grades I to III of the commercial crop of 1932–33 in the Northern Provinces, graded by the Department of Agriculture and purchased by a trading firm for shipment to the United Kingdom. The total export had amounted to about 50 tons, chiefly of Grade III. The three samples were as follows:

Standard Grade I.—Weight 2 lb.—Hands up to 3 in. long, and a few small pieces, of bold, plump ginger, which had been well scraped. Externally the hands were of pale buff colour and internally very pale straw-yellow. Some hands were fairly soft and others rather hard. The fracture was short and fibrous. The flavour, aroma and pungency were good. Many of the hands bore a whitish deposit, which gave a reaction for lime, thereby suggesting that the ginger had been slightly limed. The ginger was rather bolder than the corresponding sample of the 1931–32 series, but not of quite such good colour.

Standard Grade II.—Weight 3 lb. 2 oz.—Hands up to 3½ in. long, and a few small pieces, of fairly bold, plump ginger, which had been well scraped. Externally the hands were of pale buff colour, but not quite so satisfactory in this respect as the above sample of Grade I; internally they were very pale straw-yellow. Some hands were fairly soft and others rather hard. The fracture was short and fibrous. The flavour, aroma and pungency were good. Many of the hands showed a whitish deposit similar to that on Grade I. The ginger was very similar to the corresponding sample of the 1931–32 series.

Standard Grade III.—Weight 3 lb. 11 oz.—Hands up to 3 in. long, and a considerable amount of small hands and pieces, of plump ginger, which was fairly bold, but not so bold as the foregoing sample of Grade II. Externally the ginger was of pale buff colour, nearly as good as that of Grade II; internally it was very pale straw-yellow. The hands were well scraped and mostly rather hard. The fracture was short and fibrous. The flavour, aroma and pungency were good. Many of the hands showed a whitish deposit similar to that shown by Grades I and II.

The ginger was very similar to the corresponding sample of the 1931–32 series.

The samples were submitted to a firm of brokers in London who had been concerned in the marketing of the 1932–33 crop of Nigerian ginger. They furnished the following observations.

The firm had already disposed of a total of 30 tons of the 1932–33 crop of these three grades (mainly Grade III), the prices obtained being 45*s.* per cwt. for Grades I and II mixed, and 40*s.* 6*d.* per cwt. for Grade III. The bolder grades I and II had been sold as one parcel owing to the comparatively small amount.

The firm recommended that Grades I and II should be packed in barrels of 1 to 1½ cwt., as breakage of the hands of ginger would thus be avoided, and an increase of 5*s.* to 10*s.* per cwt. in the price should be obtainable.

They considered the whitish deposit on the present samples to be disadvantageous.

Samples 4, 5 and 6.—Blue Ginger

These three samples represented a portion of the crop which showed a blue colouration. They were as follows:

Blue Ginger, Grade I.—Weight 14 oz.—Hands up to 4 in. long, of bold, plump ginger. The general colour was buff, but most hands showed a superficial purplish tint; internally it was pale straw-yellow. The ginger was well scraped and hard. The fracture was short and fibrous. The flavour, aroma and pungency were good.

Blue Ginger, Grade II.—Weight 3 lb. 3 oz.—Hands up to 4 in. long, and pieces of plump ginger, varying from bold to fairly bold. The colour was similar to that of the foregoing sample of Blue Ginger, Grade I. The ginger was well scraped and hard. The fracture was short and fibrous. The flavour, aroma and pungency were good.

Blue Ginger, Grade III.—Weight 2½ lb.—Hands up to 3½ in. long, and pieces of fairly bold, plump ginger, which on the whole had been fairly well scraped. The colour varied from pinkish-buff to purplish-buff; internally it was pale straw-yellow. The hands were mostly hard, but

some were fairly soft. The fracture was short and fibrous. The flavour, aroma and pungency were good.

This ginger was of rather different appearance from the foregoing Grades I and II of Blue ginger, and many of the hands could have been scraped to give products coming within the Standard Grades described above.

The firm of brokers described these samples as "resinous" and stated that such ginger would be more suitable for extraction than for grinding. They considered the products to be worth from 5*s.* to 7*s.* 6*d.* per cwt. less than the corresponding Standard Grades.

The term "resinous" employed by the brokers refers merely to a condition of the material suggesting the hard vitreous nature of resins and not to an excess of resin in the samples. These samples of "blue" ginger showed this condition in the outer, coloured layer, the interior of the hands being fibrous.

Samples 1A–4A *and* 1B–4B.—*Ginger from selected and ordinary seed*

These eight samples represented the results of experiments carried out on one of the farms of the Department of Agriculture, on plots of very small size, the object being to test the relative importance of seed selection and of various methods of cultivation in the production of bold ginger. The samples are described below.

No. 1A.—*Selected seed, manured and cultivated.*—Weight 1 lb.—Hands up to 2½ in. long, and small pieces of fairly well scraped, plump ginger, of whitish-buff colour; internally the colour was very pale straw-yellow. The ginger was fairly soft and the fracture short and fibrous. The flavour, aroma and pungency were good.

No. 2A.—*Selected seed, cultivated only.*—Weight 1 lb.

No. 3A.—*Selected seed, manured and weeds pulled by hand.*—Weight 14 oz.

These two samples were similar to No. 1A.

No. 4A.—*Selected seed, weeds pulled.*—Weight 13 oz.—This was very similar to the three foregoing samples, but the colour was not quite so good.

No. 1B.—*Ordinary seed, manured and cultivated.*—Weight 14 oz.

No. 2B.—*Ordinary seed, cultivated only.*—Weight 13 oz.

No. 3B.—*Ordinary seed, manured and weeds pulled by hand.*—Weight 1 lb.

No. 4B.—*Ordinary seed, weeds pulled.*—Weight 10 oz.

All these four samples were similar to the corresponding gingers in the A series described above, with the exception that 4B was not quite so bold as 4A.

The colour of the eight samples as a whole was somewhat better than that of the sample of Standard Grade III (see p. 346), but the hands were not so bold.

The brokers considered that there was no marked difference in quality between the samples from the selected seed and the corresponding products from the ordinary seed, but they regarded Samples 1, 2 and 3 in each series as of better quality than Sample 4, and slightly superior to the sample of Standard Grade III. In their view these samples (1A–3A and 1B–3B) might possibly realise 2*s.* 6*d.* to 3*s.* 6*d.* per cwt. more than the latter grade.

Sample C.—Canton Ginger grown at Maigana

This sample, which weighed 1½ lb., represented ginger of which planting material had been obtained from Trinidad, where it had been originally introduced from China. When freshly dug the ginger was much bolder than any other type at present grown in Nigeria, but the hands had subsequently shrivelled considerably and the Department of Agriculture considered it possible that the variety might be more suitable for the preparation of preserved or crystallised ginger than for sale as ordinary dry ginger.

The sample consisted of hands up to 3½ in. long and pieces of very bold ginger, which, however, lacked plumpness. The hands, which were light brown externally and straw-yellow internally, had not been scraped or only very poorly scraped. The ginger was hard and the fracture short and fibrous. The flavour, aroma and pungency were good.

This being an unusual type of ginger, the firm of brokers to whom it was submitted could not assign a value to

it, and they suggested that a trial consignment should be sent to test the market.

General Remarks

The three samples representing the standard grades of the 1932–33 crop were, on the whole, very similar to those of the previous year dealt with on p. 344 and showed that the efficiency of the grading had been satisfactorily maintained.

The Blue ginger could probably be marketed for extraction purposes but, as indicated above, would realise lower prices than the ordinary standard grades.

The samples obtained in the cultivation trials do not indicate that the ginger grown from selected seed is superior to that from ordinary seed, nor that the different treatment of the plots had any marked effect on the quality.

The Canton ginger, being of an unfamiliar type, might not be readily saleable, and if it were desired to market this variety it would be advisable to forward a preliminary shipment for trial sale. It seems not unlikely, however, as suggested by the Director of Agriculture, that this type would be best employed for the preparation of preserved or crystallised ginger.

"BLISTER BEETLES" FROM THE SUDAN

There are a number of different kinds of beetle whose body-juice possesses vesicating or blister-raising properties. Chief among them is the common blister beetle or Spanish fly (*Cantharis vesicatoria*), the Cantharides of the pharmacist. Various preparations of these beetles are employed in medical practice, plasters and liniments being used in such ailments as pleurisy, neuritis and rheumatoid arthritis, whilst the tincture is administered internally for certain diseases. The active principle is a substance known as cantharidin. Commercial supplies of the ordinary blister beetle come from Southern Russia, Galicia, Rumania, Spain, etc.

Cantharides are official in the United States and most European Pharmacopœias, but in the present British

Pharmacopœia they are replaced by cantharidin, so that any beetle yielding this substance can now be employed in this country in its preparation.

Beetles belonging to the genus *Mylabris* also contain cantharidin and possess similar properties to the ordinary cantharides ; *M. phalerata*, for example, was at one time official in the Indian and Colonial Addendum to the British Pharmacopœia for making external applications in India. A sample of blister beetles, stated to be a species of *Mylabris*, was forwarded to the Imperial Institute by the Secretary for Economic Development, Sudan, in order to ascertain the commercial value of the beetles as a source of cantharidin.

The sample weighed about 1 lb. and consisted of somewhat coarsely powdered beetles. It was found to contain :

	Per cent.
Moisture	5 7
Cantharidin	1 3

In connection with this result it may be mentioned that Mylabris beetles are recorded as normally containing from 1 to 1·25 per cent. of cantharidin, so that the present sample is seen to be quite satisfactory from this point of view.

The beetles were submitted to two firms of manufacturing druggists, who furnished the following reports :

(1) " These beetles appear to be of good average value in cantharidin, and we shall be glad for our name to be put forward as being willing to consider receiving consignments should these become available."

(2) " Our works have carefully examined the sample, which was found to contain 1·16 per cent. of cantharidin. In regard to commercial value, the test is approximately the same as for Chinese cantharides, which is the usual commercial source. The present market value fluctuates between 1*s.* 4*d.* per lb. and 2*s.* per lb. c.i.f. London, and the Sudan beetles could be regarded as of the same value provided bulk supplies equal the sample.

" The sample as it reached us consisted of a rough powder, the beetles evidently having been crushed and powdered, and we would point out that bulk shipments

from the other side should consist of the whole beetles, to ensure the consignments reaching this country in good condition. Even then it is better for the shippers to put a little naphthalene in each of the packages for preservative purposes.

"We buy cantharides on the market from time to time, but the consumption at present is not very great. We could take now, however, a quantity of about 500 lb. to 600 lb. at 1*s.* 6*d.* per lb. c.i.f. London, provided the bulk is guaranteed equal in yield to the sample just examined."

[The Chinese "cantharides" referred to above are not true Cantharis but a species of Mylabris (probably *M. cichorii*).]

From the foregoing results it will be seen that the beetles represented by the present sample would be readily saleable in the United Kingdom, and it has been pointed out to the Sudan authorities that it would be of interest to learn whether the price mentioned by the second firm referred to would allow of the remunerative shipment of supplies from the Sudan.

ARTICLES

THE FEEDING VALUE OF TUNG-SEED MEAL

By W. Godden, B.Sc., A.R.C.S., F.I.C.

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In view of the efforts being made to encourage the production of tung oil in the Empire it was considered desirable to ascertain what use could be made of the oil-cake or residual meal left after the expression or extraction of the oil from the tung seed.

At the present time the commercial supplies of tung oil are obtained from China and there the residual oil-cake is either used as a fertiliser or is burned. If the residual material in either form could be used as a feeding-stuff this would furnish a more useful outlet for and facilitate the disposal of these by-products. At the request of the Director of the Imperial Institute, an

investigation along these lines was accordingly carried out as under.

The preparation of the meal and cake from a small consignment of seed available was undertaken by one of the principal firms engaged in the industry. The extraction of the seed by means of a solvent proceeded quite normally. The solvent used was 90°–105° Benzoline and the seed was treated below 45° C.; the meal after washing and drying was steamed for 40 minutes and then spread on sacking in a warm airy place to dry for 24 hours at 20°–30° C. Unexpected difficulty was, however, experienced in expressing the oil from the seed with the result that the cake obtained still contained 24 per cent. of oil. It was realised that this was too high a content of oil and this cake was accordingly treated with solvent as described above. During the preparation of the cake the seed was heated to about 80° C. for 20 minutes before pressing and, on removal from the press, the temperature was still above 60° C.

The two types of material were first submitted to chemical analysis, the results being shown in Table I. Sample A is the material obtained by direct extraction of the seed. Sample B resulted from the solvent extraction of the press-cake.

TABLE I

	Sample A.	Sample B.
	Per cent.	*Per cent.*
Moisture	0·53	10·47
Crude protein*	28·12	32·19
Ether extract	1·58	0·57
Crude fibre	10·93	22·04
Total ash	5·07	5·73
Soluble carbohydrates (by difference)	35·77	29·00
Acid insoluble ash	0·23	0·27
Lime (CaO)	0·70	0·83
Soda (Na_2O)	0·006	0·006
Potash (K_2O)	1·27	1·50
Phosphoric acid (P_2O_5)	1·51	1·82
Chlorine (Cl)	0·029	0·035
Iron (Fe)	0·019	0·016
* Containing nitrogen	4·50	5·15

The analytical data show that both materials were fairly rich in protein and carbohydrates and that if they were palatable and contained no noxious substance their feeding

value would be roughly equal to that of a mixture of palm kernel meal and soya bean meal, but they would be appreciably higher in fibre than this mixture.

Palatability and feeding trials were carried out with the extracted meal (Sample A) to test its suitability as a feeding-stuff for different classes of stock.

(*a*) *Rats.*—On September 26 five rats of about 200 grams weight were put on to a ration made up of 75 per cent. of their stock ration and 25 per cent. of the extracted meal. They did not appear to eat this food too readily, but it was persevered with for 21 days. Although fed *ad lib.* the rats certainly did not eat as much food as they would have done on their stock ration and they began to lose condition. During the 21 days they all lost weight seriously, as the figures in Table II show.

TABLE II. WEIGHTS OF INDIVIDUAL RATS

Date.	26.9.32.	3.10.32.	10.10.32.	17.10.32.
	grams.	*grams.*	*grams.*	*grams.*
Rat No 219 . . .	182	166	168	141
,, ,, 268 . . .	185	174	178	157
,, ,, 266 . . .	217	204	207	180
,, ,, 276 . . .	197	185	194	184
,, ,, 241 . . .	182	170	175	155

It would appear that 25 per cent. of meal was much too high a proportion to incorporate in the ration for rats.

(*b*) *Poultry.*—On September 26 seven pullets just about coming in to lay were given 20 per cent. of the tung-seed meal in their mash. They ate most of it on the first day but afterwards only pecked it over as though trying to select what they liked. They ate hardly any of the mash although this was a time when normally the birds would eat well. All they got to eat, therefore, was their scratch corn. After 10 days the percentage of tung-seed meal was reduced to 10 per cent. and after a further 4 days to 5 per cent., but still the birds ate hardly any of the mash.

(*c*) *Dairy Cattle.*—One cow in milk was given tung-seed meal mixed in to the extent of 10 per cent. in the production concentrates. It ate this the first day, but the next day it was scouring badly, and its milk yield was down half a gallon and there was some slight taste to the milk. The second day the cow entirely refused this

concentrate mixture, and a second cow, also offered a similar mixture, refused to eat it at three successive feeding times. The rejected food was put out on the midden and the few pigs that run there refused to touch it, although, in general, they eat greedily any food refuse.

(*d*) *Pigs.*—In preliminary trials with pigs of different ages, it was found impossible to get the animals to eat the material readily. It was decided, however, to attempt to carry out more extended feeding experiments with pigs to ascertain whether ultimately they would eat the material and thrive on it. The following trials were, therefore, carried out.

Fifteen pedigree Large White pigs were divided into four groups on October 20 and fed as follows:

Group 1	4 pigs	Basal ration only.
,, 2	4 ,,	Basal ration + 2½ per cent. tung-oil meal.
,, 3	3 ,,	,, ,, + 5 ,, ,, ,, ,, ,,
,, 4	4 ,,	,, ,, + 10 ,, ,, ,, ,, ,,

The basal ration consisted of:

Ground wheat	3 parts.
Ground maize	4 ,,
Sharps	2 ,,
Fish meal	1 part.

plus 1 lb. separated milk per 1 lb. of meals.

Owing to the obviously unpalatable nature of the food and the likelihood of groups 3 and 4 refusing to eat, weighings were made daily for the first 9 days in order that a careful watch could be kept on the well-being of the animals. The quantity of food fed to the pigs was initially the same—4 lb. per pig per day. Group 1 readily consumed this quantity of food, but groups 2, 3 and 4 did not and their troughs generally contained uneaten food. If the quantity of uneaten food was very great, no food was given to the defaulting group at the succeeding feed. In this way, in order to appease their hunger, the pigs were forced to eat all the food offered, but groups 2, 3 and 4 all missed a number of feeds in consequence. Never did the appetites of the pigs in these three groups warrant an increase in the quantity of food offered, but group 1 ate well and their quantity of food was increased slightly

as the experiment progressed. After 3 days the pigs in all the groups were noticed to be scouring, but the pigs in groups 2, 3 and 4 were much worse than the pigs in the control group.

On October 29 the basal ration was changed to:

Ground maize	15 parts.
Sharps	4 „
Fish meal.	1 part.

plus separated milk as before.

After the change the scouring in group 1 stopped, although it continued in the other groups. There was a marked difference in the appearance of the pigs in the experimental groups as compared with those in the control group; most of the experimental pigs having dirty skins.

On November 7 it was decided to slaughter one pig from each group to ascertain whether any pathological symptoms were apparent which might be attributed to the feeding, as the pigs in groups 2, 3 and 4 were not thriving, as may be seen from the figures in Table III.

TABLE III

Group.	1.	2.	3.	4.
No. of pigs	4	4	3	4
Total live-weight of group 20.10.32 . . *lb.* (*initial*)	342	359	372	490
Total live-weight of group 7.11.32 . . *lb.* (*final*)	438	398	393	510
Gain of group in 18 days . *lb.*	96	39	21	20
Average daily gain per pig. *lb.*	1·33	0·54	0·39	0·28
Food consumed per 1 lb. live-weight gain	3·44	7·44	10·76	14·05

After this stage no separated milk was fed.

Groups 3 and 4 were now removed from the experiment and one pig from group 3 and two pigs from group 4 were fed together as group 3A. These three animals were fed on the basal diet for a period of 7 days and then were put on to the ration containing 5 per cent. of tung-oil meal.

The experiment was terminated on November 28, as it was apparent that the pigs in groups 2 and 3A would never thrive on the experimental rations. They were

still scouring and had missed feeds. The results of the live-weight gains and food consumption are shown in Table IV.

TABLE IV

Group.		1.	2.	3A.
No. of pigs		3	3	3
Initial weight of group	*lb.*	328	296	474·5
Final weight of group 28.11.32	*lb.*	406·5	305	474
Gain on 21 or 14 days	*lb*	78·5	9	0·5
Average daily gain per pig	*lb.*	1·24	0·14	0·01
Food consumed per 1 lb. live-weight increase	*lb.*	5·07	24·67	—

The lack of growth of the pigs in group 3A is interesting in view of the fact that during the week they were on the basal ration alone this group increased by 28½ lb. in 7 days, or 1·36 lb. per pig per day for a food consumption of 4 lb. food per 1 lb. live-weight increase.

In connection with the scouring which occurred in the experimental groups and the subsequent post-mortem findings it is interesting to note that Hertkorn (1) reports that tung oil is said to cause severe ulcers when brought into contact with the skin. Whilst the materials being tested do not contain more than about 1 per cent. of oil, it is possible that there may be enough of the material causing the ulceration left in the meal to set up internal irritation and cause scouring.

Taint of meat.—Some pork from the experimental pigs fed on tung-oil meal was cooked and eaten. No objectionable taste or smell could be detected.

Post-mortem findings.—Four pigs, one from each of the four groups, were killed for post-mortem examination. In the pig receiving 2½ per cent. of the extracted tung-oil meal nothing abnormal was noted in the stomach or small intestine, but the mesenteric glands were slightly congested, and, under microscopic examination, there was some evidence of damage to the parenchyma of both liver and kidney. These pathological findings were more marked in the animals receiving the larger percentages of the oil meal and in addition there was some evidence of gastritis with small petechial hæmorrhages in both stomach and small intestine.

Summary

1. Chemical analyses of the tung-oil cake and extracted meal show them to be fairly rich in protein and carbohydrates.

2. Feeding trials with rats, poultry, cattle and pigs show that the meal contains some substance which makes it unpalatable.

3. The meal contains some irritant material which has a harmful effect on the mucous membranes of the intestine.

The writer is indebted to Mr. A. H. Blissett for the results of the pig-feeding trials and to Dr. H. E. Magee for the post-mortem examinations.

REFERENCE

1. Hertkorn : *Chem Zeit* , 1903, **27,** 635, cited by Allen, *Commercial Organic Analysis,* Volume II, p. 157.

THE KIND OF CACAO DESIRED BY MANUFACTURERS

The importance of close co-operation between the grower of cacao and the manufacturer has long been recognised. Mr. A. W. Knapp, of Messrs. Cadbury Bros., Ltd., has been amongst the foremost of those who have drawn attention to this need, and in 1914 he contributed, in collaboration with Mr. N. P. Booth of the same firm, a paper on the qualities in cacao desired by manufacturers to the Third International Congress of Tropical Agriculture, held at the Imperial Institute. His latest contribution to the subject takes the form of a brochure, prepared, with the assistance of E. Wiehr and Léon Olivier, for the International Office of Chocolate and Cocoa Manufacturers, which is printed (in French, English, Spanish and Portuguese) in the *Bulletin Officiel* of the Office for July 1933. In view of the great importance of the subject this brochure is reprinted in full in the following pages.

The Kind of Cacao the Manufacturer Wants

WRITTEN FOR THE INTERNATIONAL OFFICE OF CHOCOLATE AND COCOA MANUFACTURERS

By A. W. Knapp, assisted by E. Wiehr and Léon Olivier

Foreword

Planters, Directors of Agriculture, and others concerned with the production of cacao in the tropics, have often asked " What kind of cacao do manufacturers want ? " This brochure is an answer to the question. As each manufacturer has special tastes and preferences, it has been necessary to generalise, and where there is a difference of opinion, the opinion of the majority has been given.

In a general way the public preference for certain kinds of cocoa powder and chocolate determines the kinds of cacao beans the manufacturer wants. The more nearly the planters can supply beans which meet the public demand, the greater will be the consumption. And a greater consumption would benefit both planter and manufacturer.

The improvement in the cacao produced in West Africa reflects great credit on both the Government authorities and on the native farmers. Much, however, remains to be done.

What Botanic Variety should be grown ?

Whilst the white, or almost white, beans obtained from the Criollo cacao tree produce a finer chocolate, the difference in the finished product is not so marked as it used to be, owing to the levelling effect of improved methods of manufacture. That manufacturers attach great importance to breed is strongly reflected in the price of raw cacao, but manufacturers would hesitate to recommend the planting of Criollo, save in those areas where experience has shown it to grow well, because of the delicate nature of this botanic variety. As the modern manufacturer generally wishes to produce a standard line in large quantities, he naturally depends, in the main, on those cacaos which can be produced at reasonable

prices and which are of a very regular quality. He will only use expensive cacaos either by themselves, for special choice lines, or, mixed with cheaper kinds, to give character to a blend. In untested areas the farmer would be wise to plant Forastero, especially as this is the type of cacao which is sure of a large permanent demand. The farmer is recommended to choose his seed deliberately. Manufacturers would probably welcome a Forastero improved by a strain of Criollo, if this could be obtained without loss of vigour or yield ; and they will follow the researches of the Imperial College of Tropical Agriculture (Trinidad) on cacao breeding with great interest.

Planters will naturally ask the local Director of Agriculture for information on the best type of cacao available for planting in their particular area.

Desirable Characteristics

A consideration of the prices of various cacaos will show that, after the botanic variety, the skill shown in preparation for the market is the most important factor in determining quality and price.

The desirable characteristics will now be briefly described. The beans should be large (if natural conditions permit, less than 400 to the pound), healthy, even in size, and plump, and the shell unbroken.

The shell should be crisp and tough, but not too friable, and more or less detached from the cotyledons. On pressing powerfully with the thumb, a bean, held in the palm of the hand, should break readily into a number of crisp nibs. The odour should be clean, pleasant and characteristic. It is usually vinegary. There should be no trace of foreign odour, whether mouldy, musty or smoky. The fragments should taste fatty, refreshing, not too bitter or astringent, nutty, and neither harsh nor sour. If the bean is cut lengthways through the centre, it should be fairly open-grained. The colour of the section may be cinnamon-brown, dark-brown, purple-brown, or brownish-purple, according to the variety, but should be bright and free from mud colour or slate colour.

It may be well to insert the *Definition of the Cacao*

Bean approved by the Council of the International Office of the Manufacturers of Chocolate and Cocoa.

"A sound cacao bean should show the following characteristics :

"The inside of the bean should be brown (light mahogany to brown, according to origin), quite dry, and have an open texture due to good fermentation. It should crumble when pressed by the fingers.

"On the other hand, the chief defects are :

"1. Mould ;
"2. Grub or weevil ;
"3. A slaty or a violet colour.

"The proportion of defective beans (mouldy or grubby) may not exceed 10 per cent."

The undesirable characteristics will now be considered in greater detail.

Gathering Cacao.—Ripe and Unripe Beans

Every planter knows that ripe cacao gives the best product, but sometimes unripe, or half-ripe, cacao is gathered. This may happen from the carelessness of the pickers (especially where the harvesters are paid by contract, as in Bahia) or from the necessity to get sufficient cacao to fill the "sweat" boxes ; or, as on the Gold Coast or in Nigeria, from a desire early in the season to get the cacao on the market while the price is high. It is well known that the more unripe, or half-ripe, cacao there is present in the bulk, the greater the departure from a satisfactory fermentation. It is a question, however, whether the depreciation in quality which occurs through gathering unripe cacao is fully appreciated. In most cases it must be an economic error from the planter's point of view, because by leaving the cacao until it is ripe one obtains a greater yield, as well as a better quality.

In classifying beans, we do not usually classify unripe beans under "defectives," unless they are shrivelled. Unripe beans are usually small and flattish. As they generally ferment imperfectly, they have the violet

interior and hard texture of under-fermented cacao (these are described later under unfermented beans). In addition, the interior is often paler or whiter than normal, and the surface of the cotyledons is generally wrinkled owing to shrinkage.

White Spot

This curious defect can often be found in isolated beans in Accra, Nigeria and Bahia cacaos, and has occasionally been seen in Trinidad and Guayaquil cacaos. It did not become generally known until 1925, when a large percentage of West African beans were heavily spotted. The beans looked quite normal externally, but when the shell was removed white or brownish spots (about 0·5 mm. in diameter) were seen on the cotyledons next to the shell and between the folds. Many of the spots consisted of rough rosettes of crystalline material. The appearance of white spot in West African cacao coincided with an abnormally strong Harmattan, this powerful dry wind being accompanied by low temperatures.

Manufacturers hold various views as to the seriousness of this defect, but as long as white spot does not occur in more than 2 per cent. of the beans, no complaint is likely to arise.

Over-ripe Cacao

Unless the picking is done carefully and frequently, some cacao will be picked in an over-ripe condition. The only objection to this is that the shell is more easily broken, and beans with fractured shells are more liable to become mouldy or grubby. If the ripeness is carried a stage further the bean may become germinated. Over-ripe cacao is not usually counted as "defective," but the presence of broken beans is always detrimental, as fragments cause difficulties in roasting.

Germinated Beans

In these the germ (or radicle) pushes its way through the shell. In mild cases the chief objection is the opening up of the bean to attack by grubs or mould. Where germination is advanced it produces changes in the bean

which affect the odour and flavour detrimentally. Germinated beans rarely appear in West Indian or Bahia cacao, and their constant appearance in West African cacaos shows that more care is needed in gathering and fermenting. Cacao which is gathered in a satisfactory condition may germinate if the fermentation is not correctly followed.

Unfermented Beans

That the majority of manufacturers prefer fermented cacao is proved by their willingness to pay more for it, and although one reads of processes of " post-fermentation " one wonders how far any economical process in the factory can overcome all the defects of unfermented or slaty cacao. Although fermentation greatly improves the bean, manufacturers are aware that the planters cannot " make a silk purse out of a sow's ear," and that no fermentation, however skilfully conducted, will convert a dark purple Forastero bean into a cinnamon brown Criollo.

It is easy to recognise an entirely unfermented bean by its slaty colour, cheesy texture, etc., but under-fermented beans are not usually classified as unfermented. Yet most manufacturers will agree that under-fermented beans produce inferior products. As with under-ripe cacao, the difficulty of defining under-fermented may prevent individual parcels of under-fermented cacao being penalised. But the average price of the cacao from a district will be lowered by the frequent occurrence of a high percentage of under-fermented cacao. An under-fermented Forastero bean, e.g. Accra cacao which has been fermented three days, has a purple or violet interior. Whilst the unfermented bean is soft and cheesy, the under-fermented bean is peculiarly hard : the shell is very hard and the cotyledons are hard and compact.

A marked improvement would be made in Gold Coast cacao if the fermenting beans were mixed every two days.

It is not only the common kinds of cacao which suffer from imperfect preparation ; the fine Arriba cacao from Guayaquil generally contains about 33 per cent. unfermented, and some excellent Venezuelan cacaos are very carelessly prepared.

A number of novel procedures have been proposed to replace fermentation—heating in water at controlled temperatures, freezing, boiling, treatment with alkali, etc.—but the manufacturers at present prefer the product obtained by the ordinary well-established methods.

Washed Beans

It is generally held that the disadvantages of the thin brittle shell produced by washing quite outweigh the advantages of cleanliness, etc.

On handling, the washed shell easily breaks; broken beans store badly and are a nuisance to the manufacturer.

Drying and the Production of Mouldy Beans

One of the most serious defects of raw cacao is mould. To avoid this it is necessary that the beans should be thoroughly dried. The degree of dryness obtained will naturally depend on the humidity of the atmosphere. It has been shown that cacao containing 8 per cent. or more of moisture becomes mouldy. Cacao dried by the sun's heat is preferred, and only in case of necessity should cacao be artificially dried. When cacao is over-heated it is spoilt. If the temperature of drying does not exceed 40° C. to 50° C. and care is taken to prevent the fumes of the fuel coming into contact with the cacao, a satisfactory product can be obtained. If in artificial drying a temperature of 50° C. is exceeded, then the cacao should be specifically described as *artificially dried.*

Claying, Dancing and Polishing

Whilst all these improve the external appearance of the cacao, it is doubtful whether any of them increase the value of the beans to the manufacturer. It is unlikely that certain Venezuelan planters will cease to earth their cacao, but it is to be hoped the practice will not extend. In the main, cacaos are bought, not on the beauty of their outsides, but on their actual quality.

Cleaning

Manufacturers would prefer that cacao was well cleaned before bagging all fragments of nib, shell, twig-like dried placenta, stones, dust, palm kernels, rubbish,

etc., being removed. The flat beans which consist mainly of shell should also be removed. Otherwise the manufacturer has to pay for this rubbish—in many cases he also has to pay duty on it—and when the cacao arrives at the factory he is put to the expense of removing it. In some countries there is a local market for the black (diseased) cacao and for the sweepings (broken beans, etc.), so that their removal is encouraged. It is to be regretted that there is, at present, on the West Coast of Africa, no local use for these waste products.

Grubby Beans

These are a very objectionable form of defective cacao. The planter can help by producing the minimum of beans with broken shells and by killing any small moths (*Ephestia elutella*) seen flying near the beans during drying or bagging.

The storage of cacao in the tropics should always be discouraged—the beans run a great risk of deterioration from insect pests and from mould. Cacao from West Africa is liable to be riddled by the larvæ of the small beetle, *Aræcerus fasciculatus*, which only thrive at tropical temperatures. Whilst shipholds and warehouses need close attention, the effort to control insect pests in the consuming countries cannot be effective unless the cacao producers prevent the original infection. As inspection of the cacao will not reveal whether eggs have been laid upon it, it is essential that the planter and merchant in the tropics should avoid exposing cacao to attacks by insect pests and only store, where storage is necessary, in perfectly clean and well ventilated stores.

It is important that planters and others in the tropics should do their utmost to prevent infestation, and advice on this matter will be found in Addendum II.

Foreign Odours

Manufacturers do their utmost to avoid purchasing cacao with a foreign odour. Bad-smelling cacao may be produced by an abnormal fermentation ; from the burning fuel in artificial drying ; or by being alongside odoriferous materials during transport or storage. Occasionally one

sees beans from West Africa with tar on them. The actual percentage must be very small, but the effect, if the beans were roasted, would be appreciable. This preventible contamination may come from the use of tar on fences, roofs and roads.

Bagging

Some cacaos (e.g. a few marks of Grenada) are packed in weak bags. As cacao bags have to withstand severe handling, they should be stoutly made of coarse jute. A good material is "A" Calcutta twill; a bag made of this to hold 1·25 cwts. will weigh 2·5 lb. Some manufacturers use the bags for more than one shipment, a procedure which should be discouraged as bags are liable to act as carriers of insect pests. For easy handling and stacking the bags should be filled rather full, but not too tightly packed. Bags of Bahia cacao are very loosely packed, and Guayaquil somewhat loosely; as a result they are more difficult to lift and pile.

Transport

Once the beans are dry, they should be kept dry. Packing in sacks should be carried out in dry warehouses. Good transport to the port and good lighterage to the ocean liner are essential. The boats have to be loaded in the warm moisture-laden air of the tropics, and sometimes some of the bags are wet with the surf. It will be clear that as the boat reaches temperate regions there will be a risk of sweat damage, particularly if the boats have had to be battened down in the tropics. Every effort should be made to get the bags of cacao to the ocean liner in a dry condition. It is important that holds should be well ventilated; and contact with wood, the dampness of which could cause damage, should be avoided.

Uniform Turnout

Probably the most highly appreciated character is constancy or reliability of quality. Cacao which is obviously mixed, or which varies from bag to bag, or from month to month, is unlikely to maintain a high price. Any name which is attached to the cacao should indicate a definite standard, for example, under no circum-

stances should beans inferior in quality, ripeness, break, size, etc., be mixed with "superior" cacao. Such an action may not always seriously affect the price of a particular lot, but it affects detrimentally the reputation of cacao from that district, and finally reacts to the disadvantage of the planters themselves.

The Manufacturers' Wishes

In this brochure there is no attempt to tell the planter how to prepare raw cacao. Should the manufacturers, as a result of experiments on their own plantations, or otherwise, find any new system of fermenting or curing which gives a more desirable product than that obtained by the time-honoured methods, they will naturally pass the knowledge on to the planters. In the meantime they venture to say that if the planter only allows ripe pods to be gathered, ferments for a reasonable period, turns the cacao every two days, cures with care, and keeps the beans dry, the cacao will have the appearance and properties which manufacturers desire.

In conclusion it may be well to say that the manufacturers realise that the planters are always at the mercy of climatic conditions and that a severe drought may result in small beans, or, heavy rains in slow ripening and difficulty in drying, but as they on their part are prepared to make strenuous efforts continually to increase consumption by improving the manufactured products and advertising them widely, they look to the planters to do their utmost to improve the quality of the raw cacao.

ADDENDUM I

International Congress of the Manufacturers of Chocolate and Cocoa, Antwerp, 1930

Recommendations of the Commissions on the Production, Preparation, Packing and Shipment of Cacao Beans

1. *Criollo or Forastero.*—The cocoa and chocolate industry at present rests on Forastero cacao. The amount of Criollo cacao grown is decreasing and this is to be regretted.

2. *Gathering.*—It is important that cacao should be gathered in a ripe condition. It is appreciated that climatic conditions sometimes make this difficult, but its importance cannot be over-emphasised.

3. *Fermenting.*—The cacao should be fully fermented and the period of fermentation varied according to atmospheric conditions.

4. *Cleaning.*—It is recommended that the flat shrivelled beans, "wings," be taken out before shipping.

5. *Insect Infection.*—Preferably cacao should not be stored in the tropics, but if this is necessary every care should be taken to prevent insect infection.

6. *Washing* the cacao is undesirable.

7. *Claying* is considered to be without advantage.

8. Every effort should be made to convey the cacao to the port in a dry condition. It should be conveyed to the ocean liner as soon as possible, and should not be shipped with other cargo liable to give off moisture, or in ill-ventilated holds.

ADDENDUM II

Suggestions to Cacao Planters to Avoid Infestation of the Bean

(As approved by the British Joint Committee on Cacao Infestation)

1. Kill any cacao moth or caterpillar, or other insect, seen on drying platforms or in stores.

2. Sweep up and get rid of cacao fragments and debris from drying places, etc. Bean fragments should not be allowed to accumulate in cacao houses—in the crevices or joints—nor should the fractured shells be swept outside and allowed to accumulate. This applies to all places or rooms where cacao is dried, cleaned, sorted, bagged or stored.

3. Rooms or sheds in which cacao is dried, cleaned, sorted, bagged or stored should be cool and have the maximum ventilation, with plenty of moving air day and night. In some places in the tropics the relative humidity rises at night to 100 per cent. Obviously in such places

the amount and position of the ventilation must be regulated at night. These rooms or sheds should be well lighted.

4. All rooms or sheds where cacao is handled or stored should be whitewashed at least once a year.

5. Planters should avoid, as far as possible, the production of cracked beans. Fragile shells are produced by over-fermentation, over-drying or washing. Planters should avoid germinated beans as, like cracked beans, they allow easy access to the insect.

6. Planters should avoid producing unfermented or damp cacao beans, as the soft nature of these enables them to be more readily attacked by insects.

7. Use only clean sacks.

It will be readily understood that cacao may show no sign of infestation and yet later be obviously infested. It may be that moths have settled on the cacao and every moth has deposited 250 eggs. These eggs are altogether too minute to be noticed. The eggs may hatch out on the voyage, but the caterpillar is so minute as to escape detection. The minute "grubs" start to feed on the beans, and frequently only become obvious two or three months later when they are fully fed and come out of the cacao bags in large numbers.

EMPIRE MINERAL SUPPLIES FOR CHEMICAL INDUSTRY

The following notes give a brief indication of the Empire's production and resources of those minerals which are of particular interest to chemical industry.

Although no particular part of the British Empire can claim to be well placed as regards its independence in the matter of mineral supplies, it is worthy of note that the supplies available in the different parts of the Empire are so complementary to one another that the Empire as a whole is distinctly well placed in this respect, and compares favourably as regards independence with other parts of the world. From this point of view minerals may be divided into four groups:

1. Minerals which the rest of the world imports largely from the Empire, namely, *asbestos, china-clay, chromite, diamonds, gold, mica, nickel* and *tin.*

2. Minerals of which the Empire has ample supplies, and an exportable surplus, namely, *arsenic, cadmium, cobalt, coal, fluorspar, fuller's earth, graphite, gypsum, lead, manganese, monazite, platinum, salt, silver, strontium* and *zinc.*

3. Minerals for supplies of which the Empire depends in some measure on foreign countries, but of which it has considerable resources, namely, *bauxite, barium minerals, bismuth, copper, felspar, iron ore, magnesite, molybdenum, phosphates, talc, tungsten, vanadium* and *radium.*

4. Minerals for supplies of which the Empire almost entirely depends on foreign countries, and of which its resources are comparatively small or negligible, namely, *antimony, borates, petroleum, potash, pyrites, quicksilver,* and *sulphur.*

The position thus disclosed as regards degree of independence in the matter of mineral supplies is such that the Empire need not fear comparison with the rest of the world.

It is not possible in the space here available to deal with all the minerals included in the above four groups, and hence attention will be given here to those of more particular interest to chemical industry.

Lead.—The Empire was responsible, during 1931, for some 40 per cent. of the world's production of lead ore, and with the development of large ore reserves at several mines, such as Mount Isa, Queensland; Lake George, New South Wales; and Buchans, Newfoundland, the Empire may be said to be in quite a strong position. The famous Broken Hill lode in New South Wales is still the largest Empire producer, with a combined output in 1932 of ore equivalent to nearly 160,000 tons of metallic lead. It is closely followed by the smelters at Trail, British Columbia, Canada, to which the chief contributor is the Sullivan mine at Kimberley. India owes her position as the seventh leading producer of lead to the Bawdwin mine in the Northern Shan States of Burma.

Lead maintains its position as the most important base metal from the point of view of chemical industry on account of the widespread use of its compounds in paints and storage batteries, and of the metal in the construction of chemical plant. Much interest has been aroused by the recent discovery that the addition of small quantities of tellurium to lead modifies the latter's physical properties and, amongst other things, increases considerably its resistance to corrosion by sulphuric acid. The new ternary alloys discovered by the British Non-Ferrous Metals Research Association have been approved for cable sheaths and for water pipes.

Electrolytic processes are now being used for the production of both red and white lead and litharge.

Zinc.—With regard to this metal, the Empire's proportion of world production is about 30 per cent. of ore and 20 per cent. of metal. The sources of supply are almost the same as for lead, since ores of both metals commonly occur in the same deposits. British Columbia and New South Wales (Broken Hill) are the chief producers of zinc as they are of lead. The Burma Corporation at their Bawdwin mine produce zinc concentrates which are shipped to Belgium for treatment. The Broken Hill mines of Northern Rhodesia have recommenced the production of electrolytic zinc, the estimated output for 1933 being 18,500 tons.

The importance of zinc to the chemical industry lies mainly in the uses of lithopone and zinc oxide. Lithopone is becoming of increasing importance in the manufacture of linoleum, oil cloth, paints, enamels and rubber. Zinc oxide is important in the manufacture of artificial silks, rayons and textiles generally, rubber goods, printing inks, glass and glazes, matches, metal polishes, paints and enamels, and in pharmacy and dentistry. Zinc dust is used in the manufacture of dyestuffs, fireworks, paint and lithopone, in the precipitation of gold from cyanide solutions and in sherardising.

Silver.—In connection with the consumption of silver in the arts and manufactures, the chemist is chiefly interested in its use in the photographic industry, in which large quantities are now absorbed. In the United

States, this industry is the second largest individual consumer, accounting in 1931 for 6,605,623 fine ounces, or about 27 per cent. of the total annual consumption of that country.

Ample resources of silver exist in the Empire, principally associated with ores of other metals, from which the silver is recovered as a by-product. The cobalt district in Ontario is a noteworthy example of a mining field worked primarily for silver, which is there associated with cobalt and nickel. Silver is associated with radium ore (pitchblende) in the interesting deposits now being opened up on Great Bear Lake in the far north of Canada.

The great bulk of the Empire's production of silver is, however, obtained from gold, silver-lead, silver-lead-zinc, silver-zinc and silver-copper ores. Consequently, the leading producers are the countries which extract large quantities of gold, or of lead, zinc or copper ore. Canada produces all these, whilst Australia, India and South-West Africa produce silver from gold and from lead-zinc ores. South African silver production comes mainly from the Witwatersrand gold ores.

Bismuth.—The world's annual production of bismuth probably amounts to about 400 tons of the metal. Although considerable quantities of bismuth ores are stated to occur within the Empire, the production is quite small, but important developments have taken place in Canada during recent years with reference to the extraction of metallic bismuth from electrolytic slimes. Late in 1928 the Consolidated Mining & Smelting Co. commenced the recovery of this metal from anode sludges obtained in the refining of lead at their Trail smelter in British Columbia. A production of 166,883 lb. of metallic bismuth was recorded for 1929, but the production declined to 16,855 lb. during 1932.

A small quantity of bismuth is also produced in Canada from the silver ores of Northern Ontario in the form of silver-lead-bismuth bullion which is shipped to the United States for refining.

In the United Kingdom relatively large quantities of bismuth are obtained from the smelting of Bolivian tin ores.

Bismuth is used chiefly for the manufacture of fusible alloys and for medicinal, surgical and toilet purposes.

Tin.—The British Empire is the world's chief producer of tin, the Malayan deposits, which are dominantly alluvial in origin, being responsible for approximately one-third of the world's output. Other important deposits occur in Nigeria, India, Australia and Cornwall, as well as in various parts of South-West Africa, Swaziland, Uganda and the Union of South Africa. During recent years many improvements in mining methods and technique have been effected which are likely to secure the continuance of the Empire's prestige in tin production. Whatever change takes place in the industrial situation, tin is likely to continue to be in considerable demand ; and, in this connection, it is interesting to note that among known deposits, either as regards actual or potential resources, those of the Empire figure prominently.

Tin finds its chief application in the manufacture of tin plate and terne plate, but the metal is also widely used in alloys, while tin pipes of good quality are particularly suitable for conveying distilled water. In chemical industries tin compounds are used for a variety of purposes. Relatively large quantities in the form of " bi-chloride," " tin salts," " tin crystals," and " stannous chloride " are used in the manufacture of silk fabrics. The oxide is used largely as a constituent of enamels applied to cooking utensils, refrigerators and sanitary ware, but it is being replaced, to some extent, by zirconium oxide. In the dyeing industry, tin compounds are used as mordanting agents, yielding final colours which are characterised by their brilliance.

Copper.—While the Empire production of copper ore has in the past been small, there has been a significant and increasing output during recent years, ranging from about one-tenth of the world's total in 1929, to roughly one-third in 1932. This increase is due to important developments in Canada and Northern Rhodesia, the former deposits, especially those at the Frood mine, being particularly favoured by their intimate association with nickel and the precious metals, while the latter deposits are noteworthy for their large tonnages of uniformly dis-

seminated sulphides easily amenable to flotation treatment.

At the present time, by far the most important world producers of copper ore are the United States and Chile; but Canada, Belgian Congo, Japan, Mexico, Spain, Peru, Russia, Germany and Jugoslavia, are also substantial producers. Of the Empire producers, Canada is the most important, with an output of 130,493 tons (in terms of metal) in 1931, equivalent to nearly 10 per cent. of the world's output for that year. Northern Rhodesia, despite unfavourable world conditions, has increased her production of 5,466 tons (metal content) in 1929 to more than 87,000 tons in 1932, while during this period the total world production has fallen from 1,900,000 tons to less than half this figure.

Other important Empire producers with their 1932 productions in terms of metal are: Australia (14,658 tons), India (11,200), Union of South Africa (9,254), South-West Africa (2,400), and Cyprus (3,200).

Copper is used chiefly in electrical and allied industries, and in such alloys as brass, but much has been used for the manufacture of chemical plant, especially in distilleries and the brewing industry generally. Its latter use, however, has suffered somewhat from competition by stainless steels, although these are often less easily worked than copper and rather more expensive.

Salts of copper, notably the sulphate, have important uses in agriculture and in the pigment industry.

Nickel.—This is an outstanding example of a raw material which is almost entirely Empire-controlled, 90 per cent. of the world's output in normal times being produced from ores of the Sudbury district, Ontario, chiefly by the International Nickel Company of Canada, Ltd. The only Empire producer of nickel outside Canada is India, which in 1931 produced some 800 tons of metal in the form of speiss as a by-product in the smelting of other ores.

Before and during the war, nickel found its chief use in the manufacture of nickel-steel for armaments, but since then research has immensely widened the field both for pure nickel and for nickel in ferrous and non-

ferrous alloys. In the chemical industry malleable nickel is used in chemical plant and for laboratory equipment. Pure nickel is also employed as a catalyst in the hydrogenation of edible oils, in the manufacture of nickel oxide and nickel salts, as nickel anodes and salts for nickel plating, and the nickel elements in storage batteries.

Nickel-copper alloys have manifold uses in the chemical industry, and nickel-chrome alloys are extensively used in the electrical industry.

Platinum Metals.—One of the primary sources of these metals is in nickel-copper sulphide deposits. The Sudbury district of Ontario referred to above had for many years produced comparatively small quantities of the platinum metals, but the successful development of the Frood and Frood Extension mines of late years has added enormously to Canada's resources, as the ores of these mines carry relatively high values in the metals. The Acton Refinery of the International Nickel Company, which was erected for the purpose of recovering platinum and other precious metals from Canadian and other ores, now has an annual capacity of 300,000 ounces of platinum group metals. The Empire has also the immense resources of platinum in the Bushveld Igneous Complex of the Transvaal, South Africa. The platinum-bearing rocks have been traced over very considerable areas in the Rustenburg, Lydenburg, Pietersburg and Potgietersrust districts.

The development of South Africa's platinum deposits unfortunately coincided with a period of falling prices and consequently production has never reached the maximum possible at any of the mines. Nevertheless, the Union in 1930 produced ore containing over 55,000 troy oz. of platinum metals, thus taking third place amongst the world's producers.

An interesting discovery was made in 1926 in Sierra Leone, from which a small production has been made since 1929.

Chromite.—For some years past the British Empire has maintained its position as the world's chief producer of chromite. Possessing large reserves of this ore in Southern Rhodesia, Union of South Africa and India, it

was responsible in 1930 for nearly one half of the world's output, Southern Rhodesia contributing more than one-third to this total. During the last three years, however, there has been a considerable decrease in Empire production due primarily to world depression and the exploitation of foreign deposits more favourably situated with regard to transport.

Of the Rhodesian occurrences those of Selukwe and Lomagundi are perhaps best known. The chromite, which is of excellent quality containing from 48 to 54 per cent. chromic oxide, is shipped from Beira some 500 miles from the main sources of supply.

In India, high-grade chromite containing on an average 55 per cent. chromic oxide occurs in Baluchistan, and is exported from Karachi. The Mysore deposits yield an ore, containing 40 to 48 per cent. chromic oxide, which is exported chiefly thorugh the Portuguese port of Mormugao.

The Transvaal chromite reserves are stated to amount to hundreds of millions of tons, and, although averaging 41 to 44 per cent. chromic oxide, enjoy better shipping facilities than those of Southern Rhodesia. In consequence the ore can be marketed at a lower unit price.

Promising deposits of chromite have lately been discovered in the Kambui Hills of Sierra Leone.

It has been estimated that of the world's annual production of chromite 46 per cent. is used in metallurgy, 41 per cent. in refractories, and 13 per cent. in chemicals. Chromium stainless steels are strongly resistant to acid corrosion and are used extensively for chemical apparatus. Chromium bricks are used for lining metallurgical furnaces, while the chromates of potassium and sodium are used for tanning, dyeing and pigments.

Manganese.—The Empire produces about forty per cent. of the world's output of manganese ore, which normally averages about three and a half million tons per annum. Empire supplies come chiefly from the Central Provinces of India, the Gold Coast and the Postmasburg district in the Union of South Africa.

It would appear that only about 5 per cent. of the world's output of the ore is used for purposes other than those of a purely metallurgical character and hence the

amount used by chemical industry is relatively small, being chiefly confined to pyrolusite varieties containing a large proportion of " available " oxygen.

Potential Empire supplies exist in Australia, Canada, New Zealand, New Guinea and Palestine.

Vanadium.—Peru was formerly the main source of the world's supply of vanadium ore, but in recent years Northern Rhodesia and South-West Africa have produced more than sufficient to satisfy the needs of Europe in normal times and the output from South America has declined considerably. The Rhodesia Broken Hill Development Co., Ltd., in Northern Rhodesia produces monthly about 30 tons of fused vanadium oxide, carrying 90 to 95 per cent. of V_2O_5, and 100 tons of concentrates containing 17 per cent. V_2O_5, the material being exported mainly to England. The Abenab and Tsumeb mines in South-West Africa have exported approximately 350 tons of concentrates (probably carrying about 9 per cent. of V_2O_5) per month to be treated mostly in Germany.

Vanadium minerals have also been produced in the Transvaal and South Australia, while recent discoveries within the Empire include a vanadiferous iron ore in Southern Quebec and vanadium in the lead and copper lodes on the eastern border of the Pilbarra goldfield, Western Australia.

At least 95 per cent. of the world's output of vanadium is consumed in metallurgical works, but the remaining 5 per cent. has a variety of important uses. It has been estimated, for example, that nearly 7 tons of vanadium are required annually for catalysts in the manufacture of sulphuric acid and various organic compounds.

China-clay.—For many years the Empire has been the most important producer of china-clay in the world. Large deposits occur in the United Kingdom, Union of South Africa, India, Malay States and Australia, those of the United Kingdom being world-famous and pre-eminent for their quality. Of the average annual production in normal times of about 800,000 tons obtained in the United Kingdom, it has been estimated that 450,000 tons are used in the paper industry, 250,000 tons in pottery, 50,000 tons in textiles, and the remaining 50,000 tons in other

industries. The capacity of production, however, is considerably greater than 800,000 tons, being probably about 1½ million tons per annum, while the reserves are stated to be sufficient to last for at least a century at the normal rate of output.

Barium minerals.—Considerable resources of barytes (barium sulphate) and witherite (barium carbonate) exist in various Empire countries. There is, however, little inter-Imperial trade in these minerals, as the price realised does not permit of long-distance transportation costs. United Kingdom production is about 50,000 tons per annum, and could doubtless be increased. India and Australia are the chief Empire producers.

Barytes is used for the manufacture of the barium compounds used in the dyeing industry, in the manufacture of lithopone, barium peroxide, rat poison (barium carbonate) and fireworks (barium nitrate). It is used directly, in the finely ground state, as a filler, chiefly in paints, but also in rubber, linoleum and asbestos goods.

Witherite is a much rarer mineral than barytes, England being the most important producer in the world. It is used principally in the manufacture of barium compounds, and, in its superior qualities, in the glass industry.

Bauxite.—Extensive deposits of bauxite occur in several parts of the British Empire, especially in British Guiana, the Gold Coast, Northern Ireland, India and Australia. In 1931 the Empire produced 161,000 tons (equivalent to 15 per cent. of the world's output), of which 157,000 tons were obtained from British Guiana.

The most valuable occurrences in British Guiana lie along the banks of the Demerara River from Wismar and Christianburg to Akyma and Komaru, some 10 to 14 miles apart. The material is of high grade and particularly suitable for the production of aluminium, for which purpose it is shipped to the United States and Canada. Irish bauxite, on the other hand, being of a siliceous nature, is not suitable for aluminium manufacture, but finds its chief application in the manufacture of aluminium sulphate, for which purpose its low content of ferric oxide is an advantage.

Bauxite has been used for many years past in the re-

fining of petroleum distillates. Experimental work has recently indicated that the ignited mineral is an efficient agent for the defecation and decolorisation of sugar-cane juice. For chemical use the mineral is invariably purified or converted into one or other of the various aluminium salts employed in dyeing, printing, tanning, water purification and the treatment of sewage.

Monazite, ilmenite and zircon.—The Empire possesses large supplies, both developed and undeveloped, of the minerals monazite (a phosphate of the cerium earths), ilmenite (titanate of iron), and zircon (zirconium silicate). These three minerals, which very often occur together in the form of sands, are all used in chemical industry. The sands containing these minerals are readily concentrated and separated by electro-magnetic means, for ilmenite is strongly magnetic, monazite weakly magnetic, while zircon is practically non-magnetic. Monazite was originally the only product marketed, being the principal source of thorium nitrate for gas-mantles, whilst the ilmenite and zircon were cast aside. The development of the non-poisonous titanium-white pigment, however, and the decline in the use of gas for illuminating purposes have reversed the order of importance of these minerals and ilmenite is now the principal product. Curiously too, monazite is no longer sold on the basis of its thorium content but chiefly on account of the cerium and other rare-earth elements which it contains, as the oxides of some of these enter into the composition of the heat-radiating units of gas fires. It is also the main source of supply of mesothorium. Zircon was for many years a drug in the market, and even now very little is consumed in this country, but there is now a fair market for it in the U.S.A. and Germany, where zirconium oxide is employed as an opacifier in enamels as well as for refractory purposes. Possibly the demand may spread to this country when certain trade prejudices have been overcome.

India is the main source of supply of these three minerals, the very extensive beach sands of Travancore yielding in 1932 more than 50,000 tons of ilmenite (over 80 per cent. of the world's output), about 490 tons of zircon, and 654 tons of monazite. Ilmenite sands are also

worked, to a small extent, in Tasmania, and supply the needs of a small titanium-white industry in Australia. In Sierra Leone ilmenite is obtained in the recovery of platinum. Ilmenite is a ubiquitous mineral, and there are large Empire deposits in Canada, Ceylon and the Federated Malay States.

Phosphate of Lime.—The British Isles consumes from 600,000 to 700,000 tons of superphosphate annually, of which only about 20 per cent. is imported, the remainder being manufactured in the country from imported phosphate rock. Although there are in the Empire large deposits of raw calcium phosphate, they are as a rule too remote for the home market so that our supplies come principally from North African countries. The extensive deposits of phosphate rock on Ocean Island and Nauru supply the large Empire markets in Australia and New Zealand. The rock is of high grade and some 100 million tons are said to be available, of which one-third is on Ocean Island. In a normal year the production exceeds half a million tons. Christmas Island is also an important producer with a normal annual output of over 100,000 tons, all of which goes to Japan. Seychelles, South Africa, Canada and Australia all produce small amounts, and a promising deposit in the mandated territory of Transjordania has recently received attention, but the Empire is far from being self-supporting as regards supplies of phosphate minerals.

An interesting recent development is the manufacture of phosphoric acid and various fertilisers at the Consolidated Mining and Smelting Co.'s smelter at Trail, British Columbia. Large quantities of sulphuric acid are obtained there as a by-product in the smelting of sulphide ores of lead, zinc, etc., but the raw phosphate is obtained largely from the United States.

Radium.—For many years the Belgian Congo has held a virtual monopoly of the supply of radium, on account of the rich deposit of pitchblende and allied minerals found in the copper belt of Katanga. Recently, however, a pitchblende deposit which is reputed to have considerable possibilities has been located and opened up in the North-West Territories of Canada at Great Bear Lake. In

opening up the veins which occur in a district very difficult of access, much use has been made of aeroplanes for transport purposes, a daily service being maintained during the season with the railhead at Waterways, Alberta, 850 miles distant. The Canadian Department of Mines has assisted in evolving a process for the recovery of radium from the ore, which is unusually free from thorium, and a refining plant has been erected at Port Hope, Ontario.

During the summer months of last year, about 35 tons of dressed ore was produced and brought to the refinery; this is now being worked up, and it is hoped to produce some 5 or 6 grams of radium during the present year. Probably the whole of the product will be employed in Canadian hospitals and medical schools.

Efforts are now being made to produce radium from the ore occurring at Mt. Painter, South Australia. Other deposits of radium minerals in the Empire occur in India, South Africa and in Ontario, Canada, but none has so far proved to be capable of producing commercial supplies.

Diatomite.—Diatomite (or kieselguhr) finds a number of uses in various chemical industries, but is, perhaps, best known to chemists as a filtering medium, although larger quantities are used for other purposes. The earth is made up of the siliceous remains of minute aquatic plants and many different varieties are usually present in the same sample. It is therefore exceedingly difficult to decide which particular type of diatom is most effective as an aid to filtration, and there is no general agreement of opinion on this matter. Important deposits are worked in England, Northern Ireland, Canada and Australia, while very extensive unworked deposits are known in Kenya and smaller ones in Scotland and elsewhere. So far as can be judged from present information, very little of this Empire diatomite is suitable for filtration purposes, that from Australia being perhaps the best, but considerations of freight render it unremunerative to bring this to Europe.

Iodine.—Although most of the world's iodine is obtained as a by-product from the recovery of sodium nitrate in Chile, an increasing quantity has been obtained in the United Kingdom, during recent years, from seaweed along the coasts of Ireland and Scotland.

The Scottish kelp industry is over 200 years old, and at one period attained considerable size, but the present output is quite small. Usually the weed is dried and burned in kilns, the yield of iodine varying from 10 to 28 pounds per ton of ash. The resulting ash (kelp) is leached with water and the iodine separated by chemical treatment.

In Northern Ireland considerable quantities of weed are collected on the coast of Rathlin Island and the east coast of County Antrim and County Down. The material is normally dried and burnt near the point of collection while the resultant ash (kelp) is marketed in County Antrim.

In the Irish Free State, large quantities of weed are gathered on the west coast from Donegal to Kerry. The material is burnt on raised kilns built to Government specifications and the ash is chiefly exported to Scotland and France for treatment. Recently, however, an iodine factory was established in Galway.

The value of the kelp produced in the Free State during 1932 was stated to be £30,000, the ash realising an average price of £7 17*s*. 4*d*. per ton. Recently, however, owing to a fall in the world price of iodine, the kelp has only realised about £4 4*s*. per ton.

Potash and Bromine.—One of the most interesting developments in Empire mineral production is proceeding in Palestine, where Palestine Potash Ltd. is producing potassium salts and bromine from Dead Sea waters. Previous to the Palestine venture, the Empire depended almost entirely on foreign countries for its potash supplies, the only production being a small output of potassium nitrate obtained from the soil of old village sites in India. Although the Dead Sea output steadily increased during 1932, with an estimated total of 3,000–4,000 tons of contained K_2O, it is generally believed that the Company has restricted its activities in view of world conditions.

Mechanical equipment for the separation of carnallite was put into operation in early 1931. The water is now pumped from a depth of 175 feet where, it is said, the potassium and bromine compounds reach their maximum concentration. It is claimed that working at its maximum capacity, the plant could yield annually 70,000 tons of

material containing 80 per cent. potassium chloride and 45,000 tons of 45 per cent. material.

It is stated that the present capacity of the plant for producing bromine is about two tons per day.

The possibility of obtaining potash and aluminium salts from the mineral leucite has received attention, but in spite of the occurrence of large deposits in the Empire, such as those in Uganda, it seems unlikely that this source of potash will be exploited in the Empire in the near future.

Magnesite.—Large deposits of magnesite occur in the Empire: the Chalk Hills in Madras, India, supply a magnesite of the Grecian type. Extensive deposits of massive magnesite occur in Canada in Argenteuil Co., Quebec, and of hydro-magnesite near Atlin in British Columbia. Australia and South Africa also produce good-quality magnesite, but are not exporters. Other Empire resources are the recently discovered deposits at Smithton, Tasmania; Cranbrook, British Columbia; and in Southern Rhodesia.

In 1931 the United Kingdom imported some 19,000 tons of magnesite: one-third of this was in the form of crude magnesite obtained almost entirely from Greece, while the remaining two-thirds was dead-burnt and lightly calcined magnesite obtained chiefly from Austria and Greece, although Canada supplied 1,300 tons and India 176 tons.

Magnesite is chiefly used, after being "dead burnt" at 1,500° C., as a refractory for lining steel furnaces, but in this country it has to compete with domestic dolomite. Calcining at a lower temperature gives "caustic calcined magnesite" which still contains up to 3 per cent. carbon dioxide, and finds considerable use in the manufacture of oxychloride or "sorrel" cement for patent floors, stucco and plaster boards, and epsom salts. Magnesium bisulphite is used in paper manufacture.

Fuller's earth.—Important deposits of fuller's earth occur within the Empire, notably in the United Kingdom, India and Australia. Most of the earth produced in the United Kingdom (by far the largest Empire producer) is obtained from quarries near Reigate and Nutfield, Surrey.

Fuller's earth, which is a hydrous aluminium silicate of variable composition, is characterised by the fact that

it absorbs grease and also has the property of removing colouring matter from oils. Its principal use is for bleaching and clarifying oils, fats, waxes, etc., its original use for fulling or removing grease from cloth having been almost entirely superseded by other methods. Other uses are as a carrier for certain pigments, as a filler for paper, as an ingredient of some soaps, and for medical and toilet purposes.

Water softeners.—There is a considerable demand at the present time for base-exchange water-softening materials, both natural and artificial, for use in factories and households.

The only natural mineral used to any extent for this purpose is glauconite, but most of the commercial supplies of this mineral come from the United States. It is not generally known, however, that extensive deposits containing glauconite are available in Western Australia. The mineral is prepared for use in Australia, where it already enjoys a considerable reputation. Some has recently been brought to this country and it is claimed that it is superior in water-softening properties to that imported from the United States.

Among other minerals of interest to the chemical industry may be mentioned those containing *arsenic, cadmium, cobalt, selenium* and *strontium*, all of which, with the exception of the last-named, are recovered as by-products from metallurgical operations.

Arsenic.—This is usually obtained in the form of white arsenic or flue dust derived principally as a by-product from the roasting of certain ores of gold, tin, silver, nickel, etc. Canada, Australia and the United Kingdom are the most important Empire producers, the total output from the United Kingdom since 1870 being estimated at some 200,000 tons. White arsenic is used in the manufacture of insecticides (calcium and lead arsenates), weed-killers (sodium arsenite), cattle and sheep dips, and as a wood preservative.

Cadmium.—The rapid expansion of the cadmium industry during recent years has been due primarily to the popularity of cadmium plating and the manufacture of

"cadmopone," a cadmium pigment similar to lithopone. The metal is obtained entirely as a by-product during the metallurgical treatment of certain lead and zinc ores, and is recovered in considerable quantities in Australia and Canada. In 1932 the cadmium output of the Electrolytic Zinc Co. of Australia amounted to 354,620 lb., while that of the Consolidated Mining & Smelting Co. was 65,425 lb. The Flin Flon zinc refinery of the Hudson Bay Mining & Smelting Co. also produces residue containing cadmium.

Cobalt.—This metal is obtained in part as a by-product in the refining of copper. In 1924 the Empire produced practically the whole of the world's output of the metal, largely from Canada, but in that year the Belgian Congo commenced to be a serious competitor. Canada, India and Australia are at present the most important Empire producers, but early in the present year an output from Northern Rhodesia was recorded, and it is anticipated that both cobalt and ferro-cobalt will be produced on a commercial scale in the near future from the blister copper obtained at the N'Kana mine, which contains some 3 per cent. cobalt. Cobalt is employed chiefly in the manufacture of high-speed steels, but it is also used as a colouring agent and for making pigments and "driers."

Selenium.—The anode slimes and residues produced during the electrolytic refining of copper constitute the chief commercial source of this element. In 1931 the Ontario Refining Company of Canada recorded an output of 21,500 lb. of selenium, but it is believed that this production could be considerably increased should market requirements warrant this course. Small quantities of selenium are also produced in Australia. The material finds its chief application in the glass and photo-electric industries, sodium selenite being used in the former industry for the decolorisation of bottle glass, etc.

Strontium.—The sulphate, celestite, is the only strontium mineral exploited in relatively large quantities, the United Kingdom being the largest contributor to the world's production. This mineral is mined in the vicinity of Yate, in Gloucestershire, and is used chiefly in sugar refining and for making "red fire" in connection with pyrotechnic displays.

NOTES

Silk Exhibit at the Imperial Institute.—In co-operation with the Continental real silk manufacturers associated with the Commission Internationale de Propagande, the Silk Association of Great Britain and Ireland, as a member of the Fédération Internationale de la Soie, recently took part in a campaign the object of which was to bring the merits of real silk before users in all countries. The action taken consisted in organising a "Silk Week" from October 2 to October 7, during which special displays of silk fabrics were made by the leading retail firms throughout the country dealing in silks. At or about the same time similar organised silk displays took place all over the Continent.

In view of the work carried out by the Imperial Institute Advisory Committee on Silk Production with the object of increasing the production of raw silk in Empire countries (and in Iraq and the Sudan), it was decided to arrange in the Public Exhibition Galleries of the Imperial Institute, with the co-operation of the Silk Association, a special exhibit illustrating, by means of specimens of cocoons, reeled and thrown silks, and sample fabrics, the operations of the Silk Committee, several members of which are nominated by the Silk Association.

Samples of the present season's out-turn of raw silk from Cyprus were exhibited by Messrs. Henckell du Buisson & Co., through Mr. Norton Breton, M.B.E. (Milit.), Chairman of the Committee, and Messrs. Durant, Bevan & Co. (through Mr. W. T. Hall, a member of the Committee) exhibited current samples of silks from Jammu and Kashmir. A printed statement giving a short account of the activities of the Committee since its formation in 1916 served as an introduction to the Exhibit.

The items exhibited included :

1. MULBERRY SILK

Cocoons.—Samples of cocoons raised in Cyprus, Jammu and Kashmir, Jamaica, Southern Rhodesia, Tanganyika Territory, Palestine and the Sudan.

Raw Silk :

Cyprus.—Skeins exhibited by Messrs. Henckell du Buisson & Co., London : "First Choice," size 13/15 deniers. The type of silk now being produced at the Cyprus Silk Filature, Ltd , Yeroskipos, and used in the manufacture of fine quality lace.

Jammu and Kashmir.—1 Samples exhibited by Messrs. Durant, Bevan & Co , Ltd., London : Kashmir White "Lotus," Kashmir Yellow "Lotus," Jammu White "Neel" A, Jammu White "Neel" B, Jammu Yellow "Neel" A ; in various sizes (deniers).

2. Skeins reeled from cocoons derived from imported French seed.

Mysore.—Silk reeled with machinery imported from France; silk reeled with local reeling machinery.

Kenya.—Skeins reeled at Lyons from cocoons raised in the Colony from French seed.

SILK WASTE

Jammu and Kashmir.—Samples exhibited by Messrs. Durant, Bevan & Co., Ltd., London: Special White Sarnakh; Special Yellow Sarnakh.

Tanganyika Territory.—Samples prepared by Messrs. Wm. Thompson & Co., Ltd., Lancaster.

FABRICS.—A collection of fabrics illustrating the experimental work of the Imperial Institute Advisory Committee on Silk Production. The silk from which the fabrics were woven were produced in the countries mentioned below, reeled experimentally, and thrown and woven by firms represented on the Committee.

CYPRUS

1. *Crêpe de Chine*.—Manufactured from Cyprus silk by Messrs. Grout & Co., Ltd., Yarmouth. Materials in the gum, unweighted, weighted, dyed and finished.

2. *Tissue*.—Woven by Messrs. Warner & Sons, London, from Cyprus silk reeled by the Cyprus Silk Filature, Ltd., Yeroskipos, and thrown by Messrs. Wm. Frost & Sons, Ltd., Macclesfield.

3. *Tissue*.—Woven by Messrs. Warner & Sons, London, from Cyprus waste silk produced by the Cyprus Silk Filature, Ltd., Yeroskipos, and spun by Messrs. Reade & Co., Ltd., Congleton.

4. *Damask*.—Woven by Messrs. Warner & Sons, London, from Cyprus silk reeled by the Agricultural Department and thrown by Messrs. Wm. Frost & Sons, Ltd., Macclesfield.

5. *Damask*.—Woven by Messrs. Warner & Sons, London, from Cyprus silk reeled in France and thrown by Messrs. Wm. Frost & Sons, Ltd., Macclesfield.

JAMMU AND KASHMIR

Figured Silk (2 samples).—Woven by Messrs. Warner & Sons, London, from silk reeled in Kashmir and thrown by Messrs. Wm. Frost & Sons, Ltd., Macclesfield.

MYSORE

Damask.—Woven by Messrs. Warner & Sons, London, from Mysore silk reeled in France and thrown by Messrs. Wm. Frost & Sons, Ltd., Macclesfield.

JAMAICA

1. *Tissue*.—Woven by Messrs. Warner & Sons, London, from Jamaica silk reeled in Milan and thrown by Messrs. Wm. Frost & Sons, Ltd., Macclesfield. The first fabric to be woven from silk produced in Jamaica.

2. *Damasquette*.—Woven by Messrs. Warner & Sons, Ltd., London, from Jamaica silk reeled in the Colony and thrown by Messrs. Wm. Frost & Sons, Ltd., Macclesfield.

3. *Tissue*.—Woven by Messrs. Warner & Sons, Ltd., London, from Jamaica silk reeled in the Colony and thrown by Messrs. G. H. Heath & Co., Ltd., Macclesfield.

RHODESIA

Tissue.—Woven by Messrs. Warner & Sons, London, from Rhodesian silk reeled in Milan and thrown by Messrs. Wm. Frost & Sons, Ltd., Macclesfield. The first fabric to be woven from silk produced in Rhodesia.

TANGANYIKA TERRITORY:

1. *Damasquette.*—Woven by Messrs. Warner & Sons, Ltd., London, from Tanganyika silk reeled in Cyprus and thrown by Messrs. G. H. Heath & Co., Ltd., Macclesfield. The first fabric to be woven from silk produced in Tanganyika Territory.

2. *Tie Cloths.*—Woven from Tanganyika silk reeled in Cyprus and thrown by Messrs G. H Heath & Co., Ltd., Macclesfield.

3. *Ribbon.*—Woven from Tanganyika silk reeled in Cyprus and thrown by Messrs G H Heath & Co, Ltd., Macclesfield

IRAQ:

1. *Damask.*—Woven by Messrs. Warner & Sons, London, from Iraq silk reeled in Iraq by the Department of Agriculture and thrown by Messrs. Wm. Frost & Sons, Ltd, Macclesfield.

2. *Tissue.*—Woven by Messrs. Warner & Sons, London, using Iraq silk for the warp The silk was reeled in Cyprus and thrown by Messrs. J. T. Brocklehurst & Sons, Ltd, Macclesfield

3. *Damask*—Woven by Messrs. Warner & Sons, London, from Iraq silk reeled in Milan.

SUDAN:

Gum Twill.—Woven by Messrs Brocklehurst-Whiston Amalgamated, Ltd., Macclesfield, from Sudan silk reeled in Cyprus and thrown in Macclesfield The first fabric to be woven from Sudan silk

2. ERI SILK (*ATTACUS RICINI*)

1 Samples of eri cocoons from the Sudan; degummed eri cocoons, combed drafts and silk yarn from Assam

2 *Damask*—Woven by Messrs Warner & Sons, London, from yarn spun from Assam eri silk cocoons.

3. *Velvet*—Manufactured by Messrs Warner & Sons, London, employing a warp of silk yarn spun by Messrs Reade & Co., Ltd., Congleton, from Assam eri silk cocoons

3. ANAPHE SILK (*ANAPHE* spp)

1 A show-case from the Nigeria Court of the Public Exhibition Galleries of the Imperial Institute illustrating the life-history of Anaphe silkworms (*Anaphe* spp, *Epanaphe* sp) and the food-plant, and displaying prepared silk, native fabric woven from locally spun silk and fabric woven by Messrs. Warner & Sons, London, from yarn spun by Messrs Lister & Co., Ltd., Bradford.

2. Nests of the Anaphe silkworm (*A. infracta*) from Uganda.

3 Degummed Anaphe silk Prepared at the Imperial Institute from the nests of *A. infracta* from Uganda

4. Anaphe silk yarn.

5 Anaphe silk dyed yarn.

6. *Damask.*—Weft: Uganda Anaphe silk. Warp: Cotton. Woven by Messrs. Warner & Sons, London, using Anaphe silk yarn spun by Messrs. Reade & Co., Ltd., Congleton.

7 *Damask.*—Woven by Messrs. Warner & Sons, London, from Nigerian Anaphe silk yarn spun by Messrs. Lister & Co., Ltd, Bradford.

8 *Velvet.*—Manufactured by Messrs Warner & Sons, London. The pile of this velvet is comprised of Anaphe silk yarn spun by Messrs. Reade & Co., Ltd, Congleton, from Uganda Anaphe silk.

4 TUSSAH SILK (*ANTHERÆA PAPHIA*)

Tussah cocoons and silk from India

The statement relating to the work of the Silk Committee read as follows:

" EMPIRE SILK

" *Work of the Imperial Institute Silk Committee* "

" Practically the whole of the raw silk imported into the United Kingdom is derived from foreign countries At the present time the only countries of the British Empire producing raw silk on a commercial scale for export are Cyprus and India (Jammu and Kashmir The silk produced notably that from Cyprus is of fine quality but the quantities available for export are as yet relatively small

" The Imperial Institute Advisory Committee on Silk Production was appointed in 1916 to study the question of increasing the production of raw silk within the Empire The first steps taken by the Committee aimed at improving the quality of the silk already produced Valuable results were obtained with Kashmir and Mysore silk and Cyprus silk has now a high reputation on the market

" Special attention was given to the development of the Cyprus industry, and in 1926 a firm represented on the Committee established the first modern filature in the Island for reeling the cocoons which hitherto had been sent for the purpose to the Continent where the silk lost its identity The silk is now marketed in this country and finds a considerable outlet for lace-making, a purpose for which only the highest quality silks can be used

Concurrently countries having suitable climatic conditions were selected for silk raising experiments Silkworm eggs were supplied and the cocoons obtained were reeled on the Continent or in Cyprus The resulting silk was thrown and woven into fabrics in the works of members of the Committee The countries chiefly concerned in these experiments were Jamaica Rhodesia, Tanganyika Territory Uganda, Kenya Colony and Iraq and the experiments showed that silk of promising quality can be produced in these countries Recommendations have also been made for the development of a silk industry in Palestine In 1929–30 the Chairman of the Committee at the request of the Governments concerned visited Tanganyika Territory Uganda, Nyasaland, Southern Rhodesia and the Union of South Africa to advise as to the economic possibilities of sericulture in these countries Southern Rhodesia and South Africa appear to offer the most promising opportunities for the industry Similar visits have been made to Palestine and Australia by members of the Committee

" The Committee has also investigated the commercial possibilities of eri silk in India and other countries and of the wild Anaphe silk of Uganda and Nigeria

" The adjacent exhibits illustrate the work of the Silk Committee referred to above The fabrics include damasks, tissues crepe de Chine, velvets, tie cloths and ribbons and constitute the final demonstrations of the quality of the silks concerned Inspection of the fabrics shows that the quality is highly satisfactory "

Considerable interest was shown in the Exhibition and a number of commercial enquiries were received.

NOTES

Palm Oil for Fattening Poultry.—In a previous number of this BULLETIN (1932, **30**, 312) a report was published on preliminary trials carried out by E. T. Halnan, M.A., and E. M. Cruickshank, B.Sc., Ph.D., at the Poultry Nutrition Section of the Animal Nutrition Institute, Cambridge, on the suitability of palm oil as a substitute for mutton fat in poultry-fattening mixtures. The results were very satisfactory, but the authors suggested that it would be desirable that the experiment should be repeated on a commercial scale in order more definitely to determine the suitability of palm oil for this purpose. Arrangements were accordingly made for such an experiment to be conducted at the Southern Table Poultry Experimental Station, South-Eastern Agricultural College, Wye, and, as will be seen from the following report which has been furnished to the Imperial Institute, the results amply confirm the earlier conclusions.

EXPERIMENTS IN FATTENING WITH PALM OIL IN LIEU OF MUTTON FAT

By C. E. Fermor

Manager, Southern Table Poultry Experimental Station, South-Eastern Agricultural College, Wye

At the request of the Director of the Imperial Institute an investigation into the possible value of Palm Oil as a substitute for Mutton Fat in fattening poultry for the table has been carried out at the Southern Table Poultry Experimental Station, South-Eastern Agricultural College, Wye.

Preliminary experiments had been carried out by Captain Halnan at the Animal Nutrition Institute, Cambridge.

The investigational work at Wye has covered a longer period, under both winter and summer conditions, and larger numbers of birds have been dealt with in each experiment.

Palm oil, an Empire product, is bright orange in colour, and is solid in the temperature of this country.

The experiments were designed to ascertain :

(1) Whether the colour of the flesh was affected when palm oil was fed.

(2) Whether the increased weight obtained in fattening with palm oil compared favourably or otherwise with the feeding of mutton fat.

The breed and cross breeds used in the experiments were of the white flesh variety, being :—Pure Light Sussex, Red Sussex crossed with Light Sussex, Rhode Island Red crossed with Light Sussex.

Fattening was carried out under different conditions :

(1) Outside in the rearing quarters where the birds were trough fed only.

(2) In the fattening shed where the birds were trough fed only.

(3) Outside in crates where they were trough fed and crammed.

(4) In the fattening shed where they were trough fed and crammed.

Feeding took place three times a day in the rearing quarters and twice a day in crates and in the shed.

The following feeding mixtures were used :

(1) 13 parts Sussex ground oats.
  1 part dried skim milk.
  1 ,, mutton fat.
(2) 13 parts Sussex ground oats.
  1 part dried skim milk.
  1 ,, palm oil.

The results of the tests carried out were as follows:

(1) 60 *chickens* (30 *cockerels*, 30 *pullets*) divided into two groups of 15 cockerels and 15 pullets each, and trough fed in their rearing quarters for 10 days as follows:

1st Group	*2nd Group*
13 parts Sussex ground oats.	13 parts Sussex ground oats.
1 part dried skim milk.	1 part dried skim milk.
1 ,, mutton fat.	1 ,, palm oil.

Increase in weight obtained in 10 days :

1st Group		*2nd Group*	
Cockerels ..	13·37 oz.	Cockerels ..	12·13 oz.
Pullets ..	8·89 oz.	Pullets ..	8·77 oz.

(2) 100 *chickens* (*equal number of cockerels and pullets*) divided into two groups (25 cockerels and 25 pullets) and trough fed in fattening shed for 14 days as follows:

1st Group	*2nd Group*
13 parts Sussex ground oats.	13 parts Sussex ground oats.
1 part dried skim milk.	1 part dried skim milk.
1 ,, mutton fat.	1 ,, palm oil.

Increase in weight obtained in 14 *days:*

1st Group		2nd Group	
Cockerels	.. 16·16 oz.	Cockerels	.. 17·76 oz.
Pullets	.. 13·12 oz.	Pullets	.. 11·76 oz.

(3) 100 *chickens* (50 *cockerels and* 50 *pullets*) divided into two groups outside in crates (25 cockerels and 25 pullets), and trough fed for 10 days on 13 parts Sussex ground oats and 1 part dried skim milk.

Cramming took place for 10 days after trough feeding,
No. 1 Group having 1 part mutton fat and
No. 2 Group having 1 part palm oil
added to the mixture.

Increased weight obtained in 20 *days' fattening:*

1st Group		2nd Group	
Cockerels	.. 22·06 oz.	Cockerels	.. 23·21 oz.
Pullets	.. 16·29 oz.	Pullets	.. 15·71 oz.

(4) 100 *chickens* (50 *cockerels and* 50 *pullets*) divided into two groups in shed (25 cockerels and 25 pullets) and trough fed for 10 days on 13 parts Sussex ground oats and 1 part dried skim milk.

Cramming took place for 10 days after trough feeding,
No. 1 Group having 1 part mutton fat and
No. 2 Group having 1 part palm oil
added to the mixture.

Increased weight obtained in 20 *days' fattening:*

1st Group		2nd Group	
Cockerels	.. 23·19 oz.	Cockerels	.. 24·07 oz.
Pullets	.. 17·36 oz.	Pullets	.. 17·12 oz.

The following conclusions are drawn:

(1) That the colour of the flesh was not affected at all by the substitution of palm oil for mutton fat.

(2) That the increased weights obtained in feeding palm oil were quite as good as those made in feeding mutton fat.

Several of the birds in the tests were disposed of to private customers who were asked their opinion on the flavour of the meat. In no case was any adverse criticism received.

The Nyasaland Tea Industry.—In a very interesting "Report on Tea Cultivation and its Development in

Nyasaland" (Crown Agents for the Colonies, 1933, price *2s. 6d.*), Dr. Harold H. Mann gives an account of a personal study of the present state and needs of the tea industry in Nyasaland which should be of great value to the planter and to the Government and its agricultural advisers. Tea-growing in Nyasaland was started about thirty-five years ago at the foot of the Mlanje Mountain and has steadily and successfully developed from that time up to the present. The Nyasaland tea area (about 12,000 acres) is now the largest in Africa and the product is well established on the United Kingdom market as a recognised factor in the world's supply of tea. The whole of the commercial tea area of the Protectorate lies in two closely contiguous areas, viz. the Mlanje and Cholo Mountain districts of the Shire Highlands. These districts differ considerably as regards climate and soil in their relation to tea cultivation, but the most important and characteristic feature of both areas is the occurrence of a long dry period between May and November which proves a very significant factor in the growth of the bushes. These climatic features definitely separate the tea-growing districts of Nyasaland from the tea-growing countries of South India, Ceylon, Java and Sumatra.

The chief object of Dr. Mann's investigations were to consider how far tea extensions are possible in the Shire Highlands, what special methods should be employed to afford a maximum of success and the precautions necessary to avoid difficulties likely to arise in these districts. In dealing with these questions the author studies in turn the factors underlying the situation. He describes the Nyasaland tea soils and their treatment, the manuring of tea with fertilisers in addition to green manuring, and the methods employed in planting the bushes, which he advises should be done with much greater care than has been the case hitherto if the plantations are to yield up to their capabilities. A very useful illustrated section deals with pruning methods and is followed by valuable observations on plucking. It is well known that the yield of tea per acre in Nyasaland is comparatively low, figures quoted in the report varying from 104 lb. per acre to 196 lb. per acre. Dr. Mann discusses the probable reasons for such low returns, and considers that with closer planting and maintenance of "supplies," combined with better methods of pruning and plucking, there should be little difficulty in increasing the yield to 600–700 lb. per acre. He further discusses the quality of the tea, which is admittedly in the "common" class, and refers to possible improvements in methods of manufacture.

The author's criticisms and suggestions lead up to an expression of cordial approval of the arrangements being made for the establishment in the Protectorate of an Experimental Station for Tea. He points out that no two tea-growing industries work under exactly similar conditions and the special difficulties of the Nyasaland planters definitely call for research on the spot. Dr. Mann urges that the Station should concern itself more particularly with local problems, leaving more fundamental research to similar establishments in the great tea-growing countries.

The conclusion is reached that the extension of the tea area in Mlanje and Cholo cannot be on any very considerable scale and that in other parts of the country there is little prospect of tea cultivation. There is, however, the possibility of a very substantial improvement in the quality of the tea provided that changes in pruning, plucking and manufacture are adopted, and the yield per acre is also capable of marked increase. Such improvements should have a definite bearing upon the commercial success of the industry, which is burdened with internal freight charges between the plantations and port of shipment that compare most unfavourably with the corresponding charges of the competing industries in India and the East. Improved quality of the tea and increased yields should help the planter in meeting this very tangible handicap.

It may be added that efforts to improve the manufacture of tea are already being made on certain estates in Nyasaland in association with the Department of Agriculture, and a number of samples prepared in different ways have been forwarded to the Imperial Institute in the last year or two in order to ascertain their quality and commercial value. Three reports on these samples have so far been published in this BULLETIN (1931, **29**, 271; 1932, **30**, 263, 434) and it is hoped that further samples will be dealt with in an early number.

The Mineral Resources of British Guiana.—The following brief notes, which the Institute has received from the Governor of British Guiana, will be of interest in view of the economic geological survey of a portion of the colony which is about to be carried out under the direction of Dr. D. R. Grantham, who has been seconded from the Tanganyika geological survey for this purpose.

Although a large number of minerals of economic importance are known to occur locally, only gold, diamonds and bauxite have been exploited on a commercial basis.

Gold.—The gold-bearing areas are distributed very widely and gold has been found in all the rivers of the

Colony with the exception of the Courantyne and Berbice, where only traces have been discovered. The industry was established in 1884 and production increased rapidly until 1893–4 when it reached 138,527 ounces. Production was maintained around that level until 1902–3 after which it steadily declined owing to the greater attraction offered by the diamond industry, which was established on an organised basis at this time.

The bulk of the gold has been obtained by alluvial washing, but auriferous quartz has been worked successfully at the Peters Mine in the Puruni River, the Aremu Mine on the Cuyuni River and the Barama Mine in the North-West District. The most productive of these was the Peters Mine, from which 30,017 ounces were extracted in 4½ years. Dredging has also been carried on successfully in the Potaro District.

Diamonds.—The proved diamondiferous area of the Colony extends in a northerly and southerly direction from the Potaro River to the Cuyuni River, a distance of 150 miles, and eastward from the foot of the Pakaraima mountains for 40 miles.

The industry was established on an organised basis in 1901–2 and production increased rapidly until 1923 when 220,162 metric carats were declared.

Thereafter, owing to the general economic depression and consequent drop in the price of diamonds, production decreased rapidly until it reached the low figure of 61,780 metric carats in 1932.

In order to stimulate interest in the gold and diamond industries by the discovery of new areas, the Government organised prospecting parties under competent leaders. These parties were followed by Government Surveyors who surveyed the trails cut and recorded the results obtained.

An experiment is now being made of assisting miners to the fields and placing them on suitable claims, the owners of which recover the advances by a drawback on the gold and diamonds produced.

Transportation to the gold and diamond fields has hitherto been by boat, and, owing to numerous falls and cataracts by which the rivers are obstructed, difficult and attended by a certain amount of risk. In order to facilitate access the Government has constructed a natural-surface road from Bartica, the entrepôt for the gold and diamond fields, to Garraway Stream, a point on the left bank of the Potaro River. The erection of a steel bridge across the Potaro River and the construction of a short branch road to Tumatumari will make the Potaro the most easily and safely accessible gold and diamond district

in the Colony, and this, combined with its past record as the greatest gold and the second largest diamond producing area, will lead to renewed activity.

Road location surveys are at present in progress to determine the alignment for a branch road from the 75-mile post on the Bartica - Potaro road to a point above the Tiboku Falls on the Mazaruni River. This will provide direct overland communication between Bartica and the heart of the diamondiferous area in the Mazaruni District and will entirely cut out the dangerous falls and rapids in the Mazaruni River which in the past have proved a serious deterrent to development.

Plans have been approved for an intensive economic geological examination of the area known as the Bartica-Potaro-Tiboku triangle through which these roads will pass.

Bauxite.—Valuable and extensive deposits of bauxite in readily accessible situations have been discovered. The most extensive deposits at present known are situate in the Christianburg-Akyma District of the Demerara River, about 65 miles from the mouth of the river.

Richer but smaller deposits occur in the North-West District.

Actual mining operations for bauxite have so far only been prosecuted by the Demerara Bauxite Company (Northern Aluminium Company of Canada). This Company controls the major portion of the Christianburg-Akyma deposits referred to.

The British & Colonial Bauxite Company, which is connected with the British Aluminium Company, have tested a large area on the left bank of the Demerara River and have now selected areas to be leased to them for mining bauxite; but actual mining operations have not yet commenced.

The following table gives the production of gold, diamonds and bauxite for the past six years:

—	1927	1928	1929	1930	1931	1932
Gold (raw average fineness 918)	(oz.) 6,722	(oz.) 6,083	(oz.) 7,204	(oz.) 6,933	(oz.) 11,002	(oz.) 15,170
Diamonds (rough alluvial)	(metric carats) 178,406	(metric carats) 135,996	(metric carats) 125,790	(metric carats) 110,042	(metric carats) 63,470	(metric carats) 61,780
Bauxite (washed and kiln-dried)	(tons) 160,872	(tons) 165,422	(tons) 185,151	(tons) 117,157	(tons) 127,473	(tons) 62,507

RECENT RESEARCH ON EMPIRE PRODUCTS

A Record of Work conducted by Government Technical Departments Overseas

AGRICULTURE

Soils and Manures

Gold Coast.—The report on the work of the Agricultural Department for the period January–June 1933 states that trials have been continued and intensified on all agricultural stations with the object of finding the most profitable fertilisers or mixture of fertilisers and the most suitable amounts to apply to local crops. It has been proved many times in the past that the application of artificial manures increases the yield of local crops, but it has yet to be proved that such application is an economic proposition. Members of cocoa producers' co-operative societies were advised to follow the lead of those few societies which, with the aid of an agricultural officer, had undertaken field trials on members' farms to test the effect of fertilisers combined with soil-forking and vegetal-mulching. Trials with green manures and continuous cultivation were continued at experiment stations with the object of determining cropping and cultivation systems, which will lessen the need for the present method of shifting cultivation in native food-farming.

Nigeria.—Mr. K. T. Hartley, Agricultural Chemist, Northern Provinces, has furnished the following report on the work conducted by his Section during the half-year ending June 1933.

It was mentioned in the last Report (December 1932) that most of the manurial trials during the 1932 season had been unsuccessful. It is interesting, however, to record the results of a manurial experiment on the relative value of bone ash and Nigerian finely ground rock phosphate. The experiment was conducted on 25 one-twentieth acre plots arranged as a latin square, the treatments being, no manure, 400 and 1,000 lb. ground rock phosphate per acre, and two dressings of bone ash of P_2O_5 content equal to the rock phosphate applications. The manures were ploughed in early in 1931 and guinea corn was grown that season. In the following season, without further manuring, a crop of bulrush millet was grown, followed by cotton. The yields were:

Treatment.	Guinea corn 1931. lb per acre grain.	Millet 1932. lb per acre grain.	Cotton 1932. lb per acre seed-cotton.
No manure	1,204	424	378
Increase due to :			
400 lb rock phosphate .	102	72	−2
1,000 lb rock phosphate .	356	180	44
320 lb bone ash . .	396	268	107
800 lb bone ash . .	476	216	50
Standard error . . .	31	45	24

It will be seen that with sufficiently large dressings of phosphates, especially in a soluble form, the increase in yield of cereals is considerable even in the second season. The effect on the final crop is less certain.

Insect Pests

Locusts

Nigeria.—Mr. F. D. Golding, Senior Entomologist, Department of Agriculture, has furnished the following report on the work carried out during the first half-year of 1933.

The whole of the period under review was devoted to an ecological survey at Kalkala, an Arab hamlet near the south-western corner of Lake Chad. The object of the investigations was to determine whether the shores of Chad are a permanent breeding ground or reservation of either the Migratory Locust, *Locusta migratoria migratorioides* R. and F., or the Red Locust, *Nomadacris septemfasciata* Serv. In the autumn of 1931 an examination of the shores of Chad was made with the object of selecting a suitable locality in which to carry out an ecological survey; Kalkala was chosen and a temporary laboratory was constructed in June 1932 by the Administrative Department.

The survey was conducted in an area of about 12 square miles (two by six) bordering the Lake, which consists of a vast marsh in that district. A study was made of the fauna, the flora, the soil and climate conditions; special attention was paid to the agricultural activities of the Arabs, for man appeared to be the most important biotic factor. Standardised collections of Orthoptera were made monthly in the various habitats and observations were kept on the time of breeding of all the locust and grasshopper species encountered. The results of the survey have not yet been written up, as the identifications of some Acrididae and plants have not been completed by the various systematists in England. It is obvious that the optimum time for conducting

research of the present type is at a period when there are no swarms; the final proof that an area is a locust reservation is the observation of the transition from the solitary to the gregarious phase. After six months' study during an unfavourable period Mr. Golding has come to the following conclusions with regard to the status of the Chad area:

(1) The shores of British Chad are probably not a reservation of the Migratory Locust.

(2) The shore from Kalkala to the frontier between French Cameroon and Nigeria is probably a permanent breeding ground of the Red Locust.

These conclusions are not, of course, based entirely upon the Kalkala survey, but also upon the extensive examination of the shore made in 1931 and three additional shore surveys made from Kalkala in the period under review.

When Mr. Golding arrived at Kalkala in late December 1932, Migratory Locusts of the phases *solitaria* and *transiens* (*dissocians*) were not uncommon. By the middle of March individuals of *phasis transiens* had disappeared and *solitaria* was rare. Hoppers were found in March and April, but in spite of this new generation *solitaria* decreased in numbers up to the end of May, at which time it was very rare indeed. In early June swarms arrived in the area and when he left on July 1 stragglers from the swarm had repopulated the survey area. It is evident that most, if not all, of the individuals found from December to the end of May were derived from swarms present in the vicinity in the autumn of 1932.

Hoppers of the Red Locust have been numerous in the southern half of British Chad during the months of August and September each year since 1930. Extensive trenching and baiting operations have been carried out each year and there is only one record of a swarm of adult Red Locusts outside the Chad area. Mr. Golding was unable to decide whether the Red Locusts had reached the true gregarious phase as there appeared to be no morphological differences between solitary individuals and those found in loose swarms. The colouration of the hoppers is not that of the gregarious phase and it seems probable that the Red Locusts of Chad are mostly *phasis transiens* (*congregans*); possibly the control campaigns have prevented the transition to *gregaria*. The principal region frequented by this species is from Kalkala eastwards to Mafindere (about 12 miles); the shore in this section is chiefly under belts of *Echinochloa pyramidalis*

and *Brachiaria ramosa* and is formed of swamps at the mouths of two small wet-season watercourses connected with the river Yadseram. It seems likely that suitable conditions occur in French territory to the south and south-east of Lake Chad.

Beverages

Cocoa

Gold Coast.—The Acting Director of Agriculture, in a report on the work conducted during the first half-year of 1933 states that general investigations on cocoa have been continued in the field, the laboratory, and in sampling shipments at the ports.

Size of Beans during the past major crop season engaged attention, and methods have been devised for determining the size and weight of beans when leaving the ports; this work will be continued and should produce interesting results. A less accurate figure for size and weight of beans has been taken in the field for many years past, i.e. number of pods required to produce one pound of dry cocoa; such records are kept at all experiment stations and are of interest in showing the variations occurring with the seasons. Figures for Kpeve are as follows:

Month	Pods per lb. dry cocoa	
January	13.6	
February	12.5	
March	13.1	
April	14.1	Minor crop set during dry season
May	15.2	
June	16.3	
July	16.8	
August	12.4	
September	[illegible]	Major crop set during major rains
October	10.0	
November	11.2	
December	12.5	

Cocoa Bean Moth.—Many cocoa stores became infested by this moth, *Ephestia elutella*, during the past season. The outbreak, which is the worst on record, was probably due to prolonged storage of the cocoa. An account of preventative and control measures was prepared by the Entomologist and published by the Department as a leaflet. The Entomologist visited stores at Kumasi, Takoradi and other centres, and gave advice on methods of improving existing storage conditions. He also conducted investigations into the life history of the moth with useful results, showing that the moth lays eggs indiscriminately in stores, and that when the larvæ hatch

out they die within twenty-four hours unless cocoa beans with broken testas or cocoa debris are in the immediate vicinity. Larvæ are incapable of penetrating an undamaged bean, but the slightest injury to the testa is sufficient to allow entry. Control can therefore be best effected by the thorough cleaning of all stores and the removal of all broken beans and debris which will serve as food for the young larvæ. Stores should be constructed so as to allow thorough ventilation and facilitate frequent removal of all sweepings and waste cocoa. Debris should not be allowed to accumulate under floor-racks. The Entomologist also found a parasitic insect—*Microbracon hebator*, which merits further study.

Cocoa Bean Weevil.—The Entomologist continued an intensive study of the cocoa bean weevil, *Aræcerus fasciculatus*. He found that oviposition occurs to a greater extent during the drying of the cocoa than was previously thought to be the case, the weevils being attracted apparently to the mucilage. Experiments showed that weevils will not readily oviposit on beans which contain less than 7 per cent. of moisture and that a grub in a dry bean takes twice as long to mature as one in a wet bean. Cocoa which is quickly and thoroughly dried is therefore less likely to be seriously affected by weevil attack. These trials are being continued.

Port Inspection.—Defects and purities.—The defects and purities of cocoa sampled at the ports when about to be shipped were as follows, expressed as percentages :

Year.	Mould	Germinated	Slate	Weevil	Other defects	Purity.
1932–33	2·4	2·2	5·1	0·6	0·9	90·1

These figures show some very slight improvement compared with similar data for the previous year, when purity worked out at 80·7 per cent. The figures quoted are for weighted means of all shipments and cover the total exports for the past year, i.e. 234,000 tons.

The standard of purity of cocoa marketed by Co-operative Societies was high during the same season and shows up in striking contrast to the data given above for non-co-operative cocoa. The total produced by societies was 4,170 tons, total defects being 2·3 per cent. and mean purity 97·7 per cent. These figures of purity are remarkable because the cocoa was uniform in quality as well as pure. Every bag was carefully examined and found to be above 93 per cent. in purity.

Cocoa Producers' Co-operative Societies.—Stimulation of the movement continued and met with greater success

both as regards capital subscribed and cocoa prepared and sold through the organisation.

Progress of the past season's working is compared below with the three preceding years:

Year	No of Societies.	No of Members.	Loans No.	Loans Amount.	Paid-up Capital.
1929–30 . .	31	940	—	—	£1,328 16 0
1930–31 .	116	2,170	—	—	£1,707 19 0
1931–32 . .	275	5,137	363	£867 8 0	£3,732 1 0
1932–33 . .	391	7,890	988	£2,354 2 6	£5,369 5 0

In 1932–33 there were 357 societies which marketed their cocoa co-operatively, 4,176 tons of a mean purity of 97·7 per cent. (range 99·1 to 95·4) being sold. The average premium received for this cocoa was 10½*d.* per load or £1 12*s.* 4½*d.* per ton.

The relative importance of the movement in various districts is shown by the following:

District	No of Societies.	Members.	Share Capital £ s. d.	Cocoa sold. (*tons*)
Sefwi	26	374	107 12 0	161·1
Bekwai	36	618	351 8 0	340·6
Kumasi . . .	32	619	465 14 0	402·9
Ofinso . . .	33	631	350 6 0	416·5
Efiduase	45	1,032	594 18 0	695·0
Juaso	18	275	107 7 0	74·3
Koforidua . . .	36	556	159 16 0	223·2
Akwapim . . .	7	143	99 6 0	36·5
Krobo	43	1 362	969 2 0	441·2
Nsawam	23	485	716 0 0	346·9
Togolans-Peki . . .	35	582	388 7 0	308·0
Oda	27	513	702 6 0	286·6
Cape Coast . . .	12	270	50 10 0	100·1
Saltpond . . .	5	80	18 3 0	
Winneba	13	344	230 15 0	343·1
	391	7,890	£5,369 5 0	4,176 0

Cape Coast and Saltpond Districts are still very backward, and Juaso has made very little progress, but Winneba has definitely made a forward move this year. Krobo, Oda, Nsawam and Efiduase are the strongest areas.

Nigeria.—The following report on the work carried out by the Botanical Section, Southern Provinces, during the period January 1 to June 30, 1933, has been furnished.

Cocoa Selection.—Seedlings from the ten selected trees mentioned in previous reports have been planted out at Ibadan and Owenna. At Ibadan 40 stands of each selection are being established with the object of determining the inheritance of yield. The lay-out is in the form

of a latin square with four trees as the experimental unit. The cocoa is planted at a spacing of 15 ft. square under a temporary shade of banana and permanent shade of *Erythrina umbrosa*. Two hundred stands have also been planted with cocoa seedlings of known parentage which will form stock material for clonal multiplication of the original selections.

At Owenna investigations into the inheritance of yield within the same ten selections are being reduplicated; at the same time the lay-out is arranged to compare the relative merits of planting cocoa at 8, 10 and 15 ft. square, thus comparing the prevalent close-planting methods of the Nigerian farmer with trees at a wider spacing. Self-fertilised seed, germinated last year in nursery beds, has been used throughout this block of eight and a quarter acres. Both at Ibadan and at Owenna a record has been kept for every tree of the actual pod from which the seed was obtained, and it is hoped that data may eventually become available for the elucidation of the genetic composition of these selections.

Cocoa Investigations.—The rate of growth of young cocoa is being studied at Owenna. Measurements of height and diameter at ground level are made at fortnightly intervals on 60 trees at each of the three spacings, i.e. 15 ft. × 15 ft., 10 ft. × 10 ft. and 8 ft. × 8 ft. Measurements were commenced two weeks after the seedlings were transferred from the nursery to the field; at that time they were about six months old. Daily meteorological observations are also made.

Cereals

Guinea Corn

Gold Coast.—According to the report of the Acting Director of Agriculture for the half-year January–June 1933, in the breeding experiments, one strain of guinea corn, F17, in the third year of selection, gave an increased grain yield of 47·8 per cent. over the ordinary type at Tamale Station. Another strain, F3, was also very promising. The work will be continued during the next season, in order further to purify and test these strains.

Rice

Gold Coast.—The Acting Director of Agriculture in his report for the half-year January–June 1933 states that a beginning was made at Tamale in the selection of rice. The Botanist found considerable variations from plant to plant, and consequently there is a good prospect

of breeding strains which will yield much more heavily than the ordinary mixed types.

Milling was continued at the Government factory at Esiama, in the Western Province, and the total treated during the year amounted to 425·06 tons of paddy, all of which was grown by farmers in the neighbourhood.

The following are the milling figures:

	Tons	Per cent. paddy.
Weight of rice	272·4	64·08
Weight of broken rice	8·6	2·03
Total from 425·06 tons paddy . .	281·0	66·11

The factory completed the milling in 159 working days.

Legumes

Nigeria.—According to the report of the Botanical Section, Southern Provinces, for the period January 1 to June 30, 1933, the annual routine of single plant selection for the maintenance of purity of Popondo (? *Phaseolus lunatus* forma *macrocarpus* Van Es.), described in a previous report, was continued. This year some fourteen to fifteen acres on Moor Plantation will be sown with selected seed for experiments dealing with Popondo as a late green manure. Thirteen types of American edible beans and six Popondo hybrids are being tested in the selection plot this year against Popondo. Judging by last season's observation, it is doubtful, however, whether any of the American types will be able to compete successfully with the best local selection.

In the field, small-scale experiments were commenced last year to find the optimum time of planting Popondo through early maize and yams. So far, the end of June appears to be the best time with both crops at Ibadan.

The following statement has been supplied by the Agricultural Botanist, Northern Provinces:

Madagascar Beans.—Two cwts. of seed of the Madagascar bean were imported and grown in 1932. It appears to be rather particular as to its habitat. Whilst moderately successful in Zaria Province it failed to fruit in Ilorin and Benue Provinces, though producing a large bulk of vegetative growth. At Kano it failed completely. There is, however, ample scope for introducing this crop into the Zaria Province, and it remains to discover how to improve on last season's yields, of which the best was 200 lb. of seed from an acre. In Zaria Province both flowers and pods were attacked by a beetle, causing loss of flowers

and a large amount of damaged seed. It is anticipated that yields will be better in 1933 as the plague of beetles was caused indirectly by locusts on whose eggs the beetle lives in one stage of its life.

Green Gram.—This pulse has come into favour owing to its suitability for interplanting with bulrush millet and preceding cotton. Its special interest for the district is as a fodder crop, for previous to its introduction there was no fodder crop which could be taken as a catch crop. The bulrush millet and green gram can be sown at the beginning of the rains in early May, whilst cotton is sown in early July.

The following yields were recorded in a small experiment on intercropping with cotton:

Bulrush millet . . .	482 lb per acre (on head).
Green gram	370 lb per acre (seed)
Cotton	811 lb per acre (seed-cotton).

With green gram alone preceding cotton the yields were:

Green gram	670 lb per acre (seed)
Cotton	778 lb per acre (seed-cotton).

Sugar

Cane

Leeward Islands.—*Antigua.*—The following report on investigational work carried out during the period January–June 1933 has been prepared by Mr. F. H. S. Warneford, Agricultural Superintendent, Antigua.

1. *Spacing and Method of Planting Experiment.*—This experiment was conducted at the Greencastle Experiment Station with the variety B.H.10/12 and was designed to compare the relative merits of flat and vertical planting (45°) and of spacing at 4½ ft. × 4 ft. and 4½ ft. × 2 ft.

The area under the experiment was one acre, consisting of six beds each divided into four plots, so that there were six replicates of each treatment, viz. flat at 4½ ft. × 4 ft., flat at 4½ ft. × 2 ft., vertical at 4½ ft. × 4 ft., and vertical at 4½ ft. × 2 ft. The relative positions of the individual plots in the beds were determined by random.

The following table shows date of planting, and dates of supplying, soil condition at time of planting and supplying, and percentage germination of plants and of supplies in flat versus vertical plots with respect to each period.

Date of Original Planting and of Supplying.	Condition of Soil.	Percentage Germination "Flat" Plots.	Percentage Germination "Vertical" Plots.
3.12.31 . . .	Very wet	72	55
22 and 23.1 32 .	Very wet	43	17
3.3.32 . . .	Dry	45	91

Under wet conditions flat planting gave better germination than vertical planting, but under dry conditions the reverse was the case.

The whole field was manured with sulphate of ammonia at the beginning of August 1932, at the rate of 300 lb. per acre.

The plots were reaped as plant canes in February 1933. The following yields were obtained:

	Tons per acre.
Flat planting spaced 4½ × 2 ft.	43·1
" " " 4½ × 4 ft.	40·5
Vertical " " 4½ × 2 ft.	42·4
" " " 4½ × 4 ft.	39·4
Mean of all flat plots	41·8
" " vertical plots	40·9
" " " close-spaced plots	42·73
" " " wide-spaced plots	39·95

The last four figures are each the means of twelve plots, but an analysis of the results indicates that, although close spacing appears to have resulted in increased yields, the difference, 2·8 tons, is not statistically significant.

2. *Varietal Experiments.—Early Reaping Period.—* A. *Millars.*—The varieties cultivated at this station were B.H.10/12, B.11569, B.4507, S.C.12/4, B.417, and P.O.J.2878.

The lay-out consisted of four randomised blocks, the area of each individual plot being $\frac{1}{24\cdot 7}$ acre.

The field was cultivated with the ox plough in July 1931, banked at 5 ft. and cross-holed at 3½ ft. The experiment was planted on November 4 and 5, 1931, and supplied December 17, 1931, February 12, 1932, and March 18, 1932. All plants were disinfected with 5 per cent. formalin prior to planting and planted with the drill.

A little difficulty was experienced in establishing the plots of B.4507 and S.C.12/4 and it is interesting to note that the planting material of these varieties was obtained from fields of second ratoons.

The plots were reaped on February 7–11, 1933.

The following table shows the mean yields of cane per acre and the calculated yields of sucrose per acre.

Variety.	Tons Cane per acre.	Tons Sucrose per acre.
P.O.J.2878	57·8	6·4
B.417	46·2	4·95
B.11569	44·5	5·13
B.H.10/12	40·7	5·95
S.C 12/4	39·2	4·77
B.4507	29·6	3·06

Differences in tonnage of cane greater than 6·4 are statistically significant, therefore P.O.J.2878 is better than all other varieties and B.4507 worse than all other varieties. B.417 is better than S.C.12/4.

B. *Fitches Creek*.—The varieties cultivated at this station were B.H.10/12, B.11569, B.4507, G.140, P.O.J. 2878 and P.O.J.213.

The lay-out consisted of six randomised blocks, the area of each individual plot being $\frac{1}{21\cdot5}$ acre.

The field was cultivated with the gyrotiller in October 1931, and trenched parallel to the banks. The banks were 5 ft. wide and the plants were set at 2½ ft. intervals in the rows. All plants were disinfected with 5 per cent. formalin and were planted flat. The plots were planted on November 26–28, 1931, and supplied on January 11, 1932, and April 19, 1932.

The plots were reaped on February 21–28, 1933.

The following table shows the mean yields of cane per acre and the calculated yield of sucrose per acre:

Variety.	Tons Cane per acre.	Tons Sucrose per acre
B.11569	39·1	5·10
P.O.J 2878	37·6	5·11
B H 10/12	35·6	5·02
B 4507	34·7	4·58
G.140	34·2	4·38
P.O.J.213	32·4	3·92

Differences in tonnage of cane greater than 3·75 are statistically significant, therefore B.11569 is better than B.4507, G.140 and P.O.J.213, and P.O.J.2878 is better than P.O.J.213.

C. *Jolly Hill*.—The following varieties were cultivated at this station: B.H.10/12, B.726, B.891, B.374, B.381, and P.O.J.2878.

The lay-out consisted of four randomised blocks, the area of each individual plot being $\frac{1}{22}$ acre.

The field was cultivated with the ox plough in November 1931, and banked at 5 ft., the plants being set at 4 ft. intervals in the rows.

All plants were disinfected with 5 per cent. formalin before planting. The plots were planted on December 22–24, 1931, and supplied February 11, 1932, April 1, 1932, and May 27, 1932. The original planting was flat, supplies put in in dry weather were planted with the drill.

In March 1932 the field was manured with fish guano at the rate of 4 cwts. per acre.

The plots were reaped on March 2–7, 1933.

The following table shows the mean yield of cane per acre and the calculated yield of sucrose per acre:

Variety.	Tons Cane per acre	Tons Sucrose per acre
P O J 2878	28·4	3·80
B 726	26·7	4·07
B 891	22·7	3·45
B 381	22·0	3·06
B H 10,12	21·9	3·45
B 374	20·9	2·96

P.O.J.2878 and B.726 have yielded higher tonnages than the other varieties, but the variations between individual plots of the same varieties have been too great to allow of the experiment being statistically significant.

D. *Sandersons.*—The following varieties were cultivated at this station: P.O.J.2878, P.O.J.2714, P.O.J. 2725, B.3922, B.4596, B.H.10/12, and B.11569.

It was originally intended that the field should be cultivated with the gyrotiller, but the wet weather experienced during the latter half of 1931 rendered this impossible. The field was cultivated with the ox plough late in the year and the irregular trenching made it impossible to lay out rectangular plots as was done at the other stations. The individual plots were therefore single strips across the experimental area, the lay-out being four randomised blocks.

With the single-strip plots the border effect was very great, all varieties planted alongside P.O.J.2878 being severely suppressed.

The field was banked at 5 ft. and the plants set at 3½ ft. in the rows. All plants were disinfected with 5 per cent. formalin and were planted with the drill.

The field was planted on January 22, 1932, and supplied March 3, 1932, April 27, 1932, and June 7, 1932. It was reaped on March 9–14, 1933.

The following table shows the mean yields in tons per acre, and the percentage of sucrose in the juice:

Variety.	Tons Cane per acre.	Percentage Sucrose in the juice.
P.O.J.2878	39·0	18·1
P.O.J.2714	30·4	18·1
P.O.J.2725	22·5	17·8
B.3922	19·7	18·1
B 4596	35·0	13·9
B.H.10/12	24·0	18·7
B.11569	25 2	17·1

In view of the border effect already mentioned the tonnage figures have no significance, they are included in the report to show the extreme vigour of P.O.J.2878.

The only variety approaching it in tonnage has been B.4596, which has never chanced to be grown in a row bordered by P.O.J.2878.

Leeward Islands.—*St. Kitts-Nevis.*—Mr. R. S. Kelner, Agricultural Superintendent, has furnished the following report on work conducted in St. Kitts-Nevis during the half-year ended June 30, 1933.

Plant canes.—Variety trials with plant canes were reaped on two stations in February with the following results:

Variety	Molineux Estate		Buckleys Estate	
	Cane tons per acre	Sucrose in juice lb per acre	Cane tons per acre	Sucrose in juice, lb per acre
P O J 2878 . .	34 55	8 210	42 51	10 610
B H 10 12 .	30 30	7 540	36 70	8 880
G 119	30 00	7,440	[illegible]	9,700
B 374	30 11	7 210	31 03	7 590
B 726	29 11	7 110	41 37	11 340
S C.12/4 . . .	29 42	7 000	34 10	9,770
B 417 . . .	22 15	5,140	35 34	9 340
Means of all . . .	29 55	7,150	37 88	9,610

Significant difference for results from Molineux 5·10 tons per acre. Results from Buckleys not significant.

Ratoon canes.—A variety trial with first ratoon canes was reaped on one station:

Variety	Cane, tons per acre.	Sucrose in juice, lb per acre
B H 10/12	45·51	11,060
S C 12/4	43 41	10,240
B 374	42 57	10,280
B 726	38 16	9,100
P.O J.2725	39·80	9,120
B.417	33 10	8,260
B 381	28·60	6,820
Means of all	38·74	9,280

These results are significant, significant difference between mean yields of any two varieties being 3·94 tons per acre.

There were no manurial trials with plant canes.

An experiment to determine the optimum dressing of sulphate of ammonia, for first ratoon canes, and also to test the effect of potash when used in conjunction with sulphate of ammonia was reaped on two stations in May. The following results were obtained :

Treatment	Belmont Estate Tons cane per acre		Molineux Estate Tons cane per acre.	
	—	With Potash 240 lb per acre (K_2SO_4)	—	With Potash 240 lb per acre (K_2SO_4)
No manure	32·52	—	41·50	—
200 lb sulphate of ammonia per acre	39·01	41·30	42·74	43·34
300 ,, ,, ,,	41·86	38·60	42·98	42·80
400 ,, ,, ,, ,,	40·60	42·24	45·54	44·56
500 ,, ,, ,, ,,	43·26	43·07	44·68	44·19
Means (ammonia only, and ammonia plus potash)	41·33	41·30	43·98	43·72

The lay-out consisted of four randomised blocks. On each station the plant canes had had a normal application of pen manure.

Results from Belmont Estate were not significant.

Experiments with sulphate of ammonia only were reaped from three stations :

Treatment	Latridge	West Farm	Douglas.
100 lb sulphate of ammonia per acre . .	22·68	12·78	25·90
200 ,, ,, ,, ,, . .	27·40	14·69	29·60
300 ,, ,, ,, ,, . .	31·80	14·54	31·70
400 ,, ,, ,, ,, . .	34·80	19·05	34·10

The lay-out consisted of a 5 × 5 Latin square on each station.

It is easily seen from the figures that, under the conditions of the experiments, an application of 300–400 lb. of sulphate of ammonia per acre is the best treatment for first ratoon canes. Potash appears to have no appreciable effect on yield when pen manure has been applied to the plant canes.

A spacing experiment, laid down in 1931 with B.H.10/12 plant canes, was also reaped. Results as follows :

Treatment	Mean yield of treatment in tons per acre	Standard error of treatment means	Row width	Mean yield for row width in tons per acre	Plant distance.	Mean yield for plant distance in tons per acre.	Standard error of means
3 × 4 ft	31·84	1 45	3 ft	34 88	1 ft	35·43	0·834
3 × 2 ft	35·26	—	4½ ft	32 12	2 ft.	32 70	—
3 × 1 ft	37·55	—	6 ft	28·10	4 ft	26 97	—
4½ × 4 ft	27 00	—		—	—	—	—
4½ × 2 ft.	33·26	—	—	—	—	—	—
4½ × 1 ft.	36 11	—	—	—	—	—	—
6 × 4 ft	22·08		—	—	—	—	—
6 × 2 ft	29·58	—			—	—	—
6 × 1 ft	32·64	—	—		—	—	—

In this experiment, highest yields were obtained from the closer spacing.

In addition to the above work, fertilisers were applied to the experiments already laid down at two stations. Two "Time of Application" experiments were also laid down and fertilisers applied. These will all be reaped in 1934.

Root Crops

Cassava

Gold Coast.—The Acting Director of Agriculture, in his report for the half-year January–June 1933, states that efforts to control cassava mosaic have been continued but so far without any definite or promising results. The most hopeful method of combating the disease, which is spreading and doing considerable damage in many parts of the country, is by selection and breeding of varieties which are immune to the disease. With this object in view a collection of types is being made at Kumasi, where severe attacks are not yet known. Seeds have been collected from various types and new seedlings raised. The problem is being tackled by the Economic Botanist, the Mycologist and the Agriculturists in charge of Stations, the object being to obtain types which will be immune to the disease and at least equal in yield and palatability to the best varieties now obtaining. Plantings have been made at Aburi and Kpeve, where the disease is serious. These will provide further information on the relative resistance or immunity of the new types.

Nigeria.—The report of the Botanical Section, Southern Provinces, for the period January 1 to June 30, 1933, states that collections of the local types of cassavas and yams were started a year ago. To date, seventy-five

samples of cassava and one hundred and forty-five of yams have been grown. Naturally it will take some time to work over this material. Several cassava samples have so far shown an apparent immunity to mosaic, and this year they will be subjected to careful experiment in this respect. Resistance to mosaic combined with real utility are the criteria by which each type is at present judged. The work with yams is not so far advanced, but it is hoped to make the preliminary groupings on general characters at the end of this season.

Coco-yams

Gold Coast.—According to the report of the Acting Director of Agriculture for the half-year January–June 1933, the investigations on coco-yam root rot, referred to in the previous report (this BULLETIN, 1933, **31**, 247), have been continued and meantime outbreaks of the disease have been reported from several other areas. The problem of controlling the pest is being attacked along several lines: by soil amelioration and soil sterilisation trials, by the breeding and importation of new varieties with a view to isolating a strain which is immune, and by mycological study of the micro-organisms concerned. Pot experiments and field trials with certain compounds and drenches have shown that some degree of control can be effected by sterilising the soil, and other trials with combinations of lime, potash and phosphates have indicated that soil improvement is unlikely to provide successful control. Until recently only two fungi, *Fusarium* sp. and *Rhizoctonia* sp., had been isolated from the rot, but the isolation of a third fungus, *Pythium* sp., has widened the field for investigation considerably.

Yams

See above, under Cassava—Nigeria.

FRUITS

Banana

Sierra Leone.—Mr. C. Hargreaves, Entomologist to the Department of Agriculture, in the report on the work of his Section for 1932, mentioned that in connection with trial shipments of bananas from Sierra Leone to England, a spotting of the fruit was reported to be a serious objection, and that observations pointed to the probability of its being caused by the feeding of aphides. In a further communication just received, Mr. Hargreaves states that

the aphid in question proves to be *Pentalonia nigronervosa* Coq., which is the reputed carrier of bunchy-top, a disease of bananas.

Citrus

Gold Coast.—The Acting Director of Agriculture, in his report for the half-year January–June 1933, states that experimental work on citrus fruits has been intensified. An 8-acre field has been laid out at Asuansi Station and plots established in lemons, grapefruit, oranges and tangerines. The citrus plot at Aburi has been extended, and budded trees are now producing their first crop. Arrangements are in progress with the establishment of plots at Kpeve. Most of the well-known varieties are already established in the country and the number is being added to as opportunity arises. The objects of these trials are first to find out which varieties are most suited to Gold Coast conditions, and to the requirements of the markets for fresh fruits, juices and essential oil, and later to provide adequate supplies of young plants for distribution.

Further progress was made in the investigations which aim at devising means for the control of citrus fruit-piercing moths. The Entomologist continued the search for plants on which the larvæ of these moths feed, and he was successful in finding feeding larvæ of *Achæs lienardi*, one of the most destructive species; larvæ are now being bred in captivity so that the life history of the moth can be studied. Three main methods of control in the field were tried: daily removal of all ripe fruit, early harvesting of fruits and the setting of poison baits. Results are still inconclusive, but the most promising means of control is to harvest the spring crop a few weeks earlier than usual, because severe attack usually lasts for a period of only three weeks in the height of the spring harvest and because unripe fruits are attacked less than ripe ones and suffer less when attacked. Fruits which are not fully ripe heal more quickly after being pierced and often suffer no vital damage, whereas fully ripe fruits usually rot after attack. The seriousness of the depredations of these pests may be gauged from the fact that over 90 per cent. of the oranges and grapefruits produced on Agricultural Stations were lost, by moth attack, during the past season.

Leeward Islands.—*Dominica.*—According to the report furnished by Mr. F. G. Harcourt, Agricultural Superintendent, the investigational work of his Department during the half-year ended June 30, 1933, continued

very closely along the lines indicated in the previous half-yearly report (see this BULLETIN, 1933, **31**, 251), and may be classified as before, with the addition of two new heads, viz. (6) Economic Section of the Botanic Gardens and (7) Demonstration Plots at the Experiment Station.

1. *Lime Breeding.*—There are still a few seedling lime trees which have not yet borne more than one or two fruits. No tree combining all the good qualities of the West Indian lime with complete immunity from withertip has yet appeared, although a few trees continue to show sufficient promise to justify their use in further breeding work.

Of the two hundred seedlings mentioned in the last report, resulting from back-crossing with the West Indian lime, many have been grafted and will be ready for planting out this year.

During the past flowering season some of the most promising of the original Woglum × West Indian lime crosses were artificially self-pollinated, and some further back-crossing done.

2. *Trials of Stocks for Limes.*—With regard to these trials which are described in earlier reports, there is little to record. The young trees are developing fast, and are bringing back to the Experiment Station the flourishing appearance it had before the destruction of the seedling trees.

The value of the sour orange stock was again demonstrated at the Experiment Station by the satisfactory crop produced by two plots of lime trees budded on this stock. These trees were planted in 1914, and together with plots of seedlings originally formed part of a manurial experiment. The seedling trees were killed long ago by the effects of hurricane damage and Red Root disease. In 1932 the two plots produced 93 barrels of limes, a calculated yield of 186 barrels per acre.

3. *Grapefruit and Orange Variety and Stock Trials.*—The young trees in these trials at the Government Fruit Farm are growing satisfactorily.

4. *Estate Development Work at the Government Fruit Farm.*—Very detailed cost accounts of all cultural operations are kept, and it is now possible to ascertain the cost per plot and the costs per tree for each plot. The figures, which are increasing in interest as the development of the estate proceeds, already show considerable variation from plot to plot.

5. *Plant Distribution.*—The work of propagation and training citrus plants in readiness for their distribution during the planting season, which began in June, was

continued throughout the half-year. The number of grapefruit trees produced in proportion to the number of lime trees is greater than in previous years, growers now being advised to plant grapefruit rather than to continue the large-scale extension of their lime cultivations.

6. *Economic Section of the Botanic Gardens.*—The work of replanting this section of the gardens was carried a step further during the half-year by the removal of the cocoa trees from three of the old manurial experiment plots. These experiments were in progress for many years, and their results are summarised in the Annual Reports on the Department for 1922–23, p. 36, and 1929–30, p. 6. The trees were so seriously damaged in the hurricane of 1930 that the experiments had to be discontinued. The lay-out of the plots has now been changed, and preparation made to re-plant them with a collection of citrus varieties, one of the main objects in view being the determination of the cropping seasons of standard grapefruit and orange varieties.

7. *Demonstration Plots at the Experiment Station.*—In addition to the plots mentioned under Head 2, several acres of demonstration plots of limes, grapefruit and other crops are maintained at the Experiment Station to demonstrate the use and value of good cultural methods, such as contour draining, mulching and cover-cropping. In view of the increased interest shown in grapefruit in Dominica the following details of two of these plots are of considerable interest: Upper and Lower Grapefruit Plots. The Upper Plot was planted in 1914, and the Lower in 1915. They produced during 1932 a good crop of excellent fruit, which ripened rather late, and was picked in January 1933, and exported, through the Government Marketing Depot, to Bermuda and Canada. The following figures give details of the plots and of the prices realised:

Area	0·5416 acre
Number of bearing trees	57
Crop exported	102 crates
Calculated yield per acre	200·11 crates
Average yield per tree	3·30 crates
Net return	£54 3s 9d
Calculated per acre	£100 1s 0d.
Return per tree	£1 2s. 5d
Return per crate	6s 8d

Nigeria.—The following report on the work of the Botanical Section, Southern Provinces, during the period January 1 to June 30, 1933, has been furnished.

Introductions.—Reports on samples of oranges and grapefruit from the orchard at Moor Plantation, Ibadan,

have confirmed the view that the quality is not up to the standard required by European markets. The introduction from abroad of better varieties therefore became essential. As was mentioned in the 1932 June report, a start was made by introducing budwood of several varieties of grapefruit and lemon and one variety of orange from Sierra Leone, through the courtesy of the Director of Agriculture. A satisfactory number of budded trees from this material have been planted at Ibadan and Agege. All available budwood, taken when the trees were cut back prior to transplanting, has in turn been used on further stocks.

Additional introductions from other sources were thought desirable, and in this connection valuable advice, both on the localities from which these should be made and on the varieties considered most suitable, was offered by Mr. F. A. Stockdale, Agricultural Adviser to the Colonial Office, and by Dr. Walter T. Swingle of the United States Department of Agriculture. Introductions have consequently been made as follows :

From Messrs. Glen St. Mary Nurseries, Florida :
- 35 grapefruit trees, including six varieties.
- 25 orange trees, including five varieties.
- 5 Tahiti limes.

From Messrs. Armstrong Nurseries, California :
- 16 orange trees, including four varieties.
- 12 lemon trees, including three varieties.
- 4 Algerian tangerines.

Out of this total of 97 trees, only one arrived dead, and since planting only one has, up to the present, died. Taking into account the distances these consignments had to be shipped and railed, credit must be given to the care in preparation for transport that the trees received.

Further introductions, this time in the form of budwood, have been made from Trinidad through the collaboration of the Department of Agriculture of that Colony. Budwood of two grapefruit varieties and three orange varieties were packed in five thermos flasks for shipment. On arrival, the contents of two of these flasks were found to be bad ; budwood in the remaining three was in a satisfactory condition. This method of transporting budwood over long distances seems worthy of consideration on account of the low costs entailed.

Citrus Stocks.—About two acres at Moor Plantation, Ibadan, have been set aside for varieties of citrus from which seedling stocks will be obtained. The main varieties,

of which sour orange is at the moment considered most suitable, have been established. Nursery beds of seedling stocks are also being established to form material for the rapid propagation of the imported citrus as opportunity arises.

SPICES

Ginger

Nigeria.—According to the report of the General Agricultural Section, Northern Provinces, for the period ending June 30, 1933, just over 53 tons of cured ginger were bought for export by Messrs. The United Africa Company, details of the purchases being as follows :

Grade	I	1 cwt 2 qrs .	3⅝*d* per lb
,,	II	2 tons 5 cwts 0 qrs 12 lb .	3⅛*d* ,, ,,
,,	III	48 tons 0 cwts 3 qrs 21 lb	2⅝*d* ,, ,,
,,	IV	(Other ginger) 2 tons 6 cwts 0 qrs 11 lb	1½*d* ,, ,,

Quality showed an all-round improvement as compared with the previous season, and the rather disappointing tonnage purchased—an increase of 14 tons as against 30 anticipated—was to a large extent offset by the spread of production into areas hitherto untapped, a development which augurs well for the future.

Selection work on local seed is being continued, and a sample of cured ginger obtained from the Canton variety sent from Jamaica last year has been sent home for report (see page 349).

OIL SEEDS

Oil Palm

Nigeria.—According to the report of the Botanical Section, Southern Provinces, for the period January 1 to June 30, 1933, the earliest planted portion of the Yield Test Blocks in the oil palm breeding experiments, described in previous reports, have now commenced to yield. Although it is as yet too early to attempt to draw any conclusions on the inheritance of fruit form, it seems likely that theories tentatively held at present may require revision. At the same time the possibility of errors in pollination must not be overlooked, as it will be remembered that the whole work of controlled pollination has been carried out by an African assistant at Calabar with only occasional supervision from headquarters. Now that the oil palms have been established at Moor Plantation, Ibadan, all the work is to be transferred there, where the technique of controlled pollination

can be reinvestigated and any improvements made. It is expected that a programme of controlled pollination will be recommenced some time during 1934 at Ibadan.

Mantled thin and mantled thick shell varieties have been planted in accordance with the general lay-out of the Yield Test Block at Ibadan. One acre has been planted at Benin with cross-pollinated palms; these have been closely spaced at 220 stands to the acre with the object of obtaining data on the inheritance of fruit form without regard to yield. After fruiting has commenced and determinations have been made thinning will be carried out.

Shea

Gold Coast.—The Acting Director of Agriculture, in a statement on the work carried out during the half-year January–June 1933, reports the results of trials made with shea nut residues. The cake from the filter presses, after extraction of the fat, was tested by the Animal Health Department as a feed for pigs and at Tamale Station as a manure. In both cases the effect of the cake was harmful, causing sickness to the animals and apparently depressing the yields of maize.

Fibres

Cotton

Gold Coast.—According to the report of the Acting Director of Agriculture for the half-year January–June 1933, field trials with cotton at Kpeve Station in Southern Togoland were continued. Yields in the season 1932–33 were a record, and the imported Nigerian cotton (Improved Ishan) maintained its reputation as a superior yielding cotton to Togoland cotton (Sonko). The results during the last three years are of sufficient interest to be recorded here:

Season.	Yield results at Kpeve.			
	Sonko Seed-cotton lb. per acre	Ishan Improved Seed-cotton lb. per acre.	Increase of Ishan as compared with Sonko.	No. of plots of each variety.
			Per cent.	
1930–31	283	499	+ 76	20
1931–32	360	544	+ 51	20
1932–33 Progeny plots	747	978	+ 32	1
Plots planted end of May	645	1,026	+ 58	4
Time planting trial (from end of May to beginning of July)	315	594	+ 88	20

The Ishan cotton not only gave the high yield of 1,026 lb. of seed-cotton per acre when sown at the best planting-date, but yielded considerably better than Sonko cotton in the later sowings. The Ishan cotton was also tested on twenty half-acre plots cultivated by farmers in villages throughout the cotton-growing area ; the yields of these plots ranged up to 696 lb. of seed-cotton per acre. An excellent report on the quality of the Ishan cotton was received from the ginnery at Lome in French Togoland.

Nigeria.—The following report on the work of the Botanical Section, Southern Provinces, for the period January 1 to June 30, 1933, has been furnished.

Cotton Yield.—Yields of improved Ishan A cotton during the past season (1932–33) on Moor Plantation show little change from the preceding crop, which was itself only a bare average. It appears, however, that the low yield for the 1932–33 season was due to exceptional drought conditions shortly after planting, and this view is confirmed by the high yields from those plots which were established early. Figures for the past four seasons are as follows :

1929–30	=	545	lb. seed-cotton	per	acre.
1930–31	=	407	,,	,,	,,
1931–32	=	378	,,	,,	,,
1932–33	=	392	,,	,,	,,

Cotton Breeding.—The elimination of a certain roughness in the lint of Ishan cotton, and at the same time the maintenance of the valuable agricultural characteristics for which this cotton is noted, is proving the major problem in breeding and selection at Ibadan. This roughness has been recognised early in the history of Ishan cotton selection, and as mentioned in previous reports, Strain A was crossed with the smoother linted but otherwise less desirable Strain E. Eighteen strains of this AE cross were planted last season in the selection plot, and of these eleven were discarded early, one after examination, and six were retained. Three of the most promising strains of those retained are now to be planted on a field scale for trial against Ishan A. A further attempt to improve the smoothness of Ishan lint was initiated in 1931, when, on Dr. Harland's advice, crosses were made between this cotton and Sea Island. The F_1 of these crosses were planted in the selection plot and were back-crossed with Ishan A. Successive back-crossing is to continue.

As anticipated in the January report, the five New Guinea Kidney by Sea Island strains proved quite unsuitable to Ibadan conditions. As it is considered impracticable to employ this cotton as a parent in a programme of crossing, these strains have been discarded.

Mr. C. B. Taylor, Agricultural Botanist, Northern Provinces, reports as follows:

Selections.—Strain L, the Allen selection, which it is proposed to introduce into general cultivation this season, is being grown in the following stages of multiplication:

Breeding plot .	Progeny of a single plant.
Isolation plot .	3 acres (seed from 1932 breeding plot, all seed selfed).
Maigana farm .	50 acres (seed from 1932 isolation plot)
Daudawa farm .	500 acres (seed from 1932 crop at Maigana).
Dan Ja . .	Special area of native farmers, 4,000 acres (seed from 1932 crop at Daudawa).

The 1935–36 season should see this strain grown over the greater part of the cotton area of the Northern Provinces, and if the price of cotton rises appreciably the native farmer will in all probability receive a small premium.

Breeding for Yield.—Until the 1930 season all the efforts were concentrated on improving the quality of Allen cotton. But in that year a number of selections were made for yield, combined with average quality. This last season was the first year in which any of these selections were tested in a yield trial. Five strains were tested; no one beat Allen and two failed miserably. It is to be hoped that other selections which are being tested this season will be more productive.

Crossing.—For some time it has been apparent that straight-forward pure-line selection and the introduction of improved varieties from abroad were unlikely to produce any cotton superior to ordinary Allen or L and it was decided to resort to hybridisation. A beginning was made therefore in 1932 by crossing various improved strains with one another, the following strains being used.

1. Strain L (an Allen selection) for general merit.
2. Strain C (an Allen selection) for length, hairiness and yield.
3. H21 (Hartsville) for freedom from immaturity.
4. U4/123 for reputed freedom from immaturity and hairiness.

All possible crosses have been made except H21 × U4/123 and the reverse cross.

The F_1 generation has been grown under irrigation during the dry season. This generation has been selfed, but the F_2 generation will be back-crossed with one or other of the parents.

Cotton in the Middle Belt.—In a previous report it was stated that U4 and Coimbatore 2 appeared promising in the 1931–32 season. It should be mentioned, however, that they had been then grown under particularly favourable conditions, as a sole crop without competition from yams, and with stainer control. In the 1932–33 season they were subjected to a more rigorous test and were not assisted in any way. The results were not so promising, and practically dispel any hope of our introducing either of these cottons into general cultivation.

A trial of selections from the local cottons against the local type at Yandev, in the Benue Province, produced no outstanding types.

According to the report of the General Agricultural Section, Northern Province, for the period ending June 30, 1933, nearly 22,000 bales of American cotton were purchased for export last season, the quality of which was well up to average. There has been a keen demand for seed during the past two months, and if climatic conditions are reasonably favourable over 30,000 bales should be purchased next year.

Drugs

Kola

Nigeria.—According to the report of the Botanical Section, Southern Provinces, for the period January 1 to June 30, 1933, an experiment on different methods of pruning was initiated in 1931 on a 2½-acre plot of red Gbanja Kola, *Cola acuminata*, Schott et Endl., planted in 1913. Since pruning, harvests from two seasons have been obtained, and there are indications of relative merits of the various treatments. Normal pruning, which was undertaken to thin the top canopy and shade the trees, had no significant effect on yield compared with those unpruned. Partial ring barking, obtained by removing a strip of bark half an inch wide from one side of the trunk, was held to cause increased yields, while root pruning had the opposite effect. Individual tree yields throughout the plot were so variable, irrespective of the treatments received, that further confirmation of the results outlined above is to be sought.

MINERAL RESOURCES

CYPRUS

The following particulars regarding mining in Cyprus during the six months ended June 30, 1933, have been received from the Acting Colonial Secretary.

There appears to be a slight improvement in the demand for minerals, and mining activities in the Colony have increased accordingly.

The Cyprus Mines Corporation has decided to embark on a larger scheme for the dressing of their ore, and it is anticipated that the Mavrovouni mine will supply the greater proportion of the required tonnage.

The following tables indicate the work carried out by the various mining concerns in the island:

Work done by the Cyprus Mines Corporation at the Skouriotissa Pyrites Mines

	First 6 months 1933	First 6 months 1932.
Tonnage mined	108,745	50,667
Tonnage exported	101,180	50,477
Underground labour (average per day)	618	341
Total surface and underground labour (average per day)	1 308	898

Work carried out at the Mavrovouni mine by the Cyprus Mines Corporation

	First 6 months 1933.	First 6 months 1932.
Prospect drilling (underground) ft	nil.	355
Development, total footage	nil	6,889
Tonnage mined	119	29,863
Tonnage exported	6,071	17,868
Underground labour (average per day)	11	321
Total surface and underground labour (average per day)	85	678

Work done at the Lymni mine of the Cyprus Sulphur and Copper Co. Ltd.

		First 6 months 1933.	First 4 months 1932.
Underground development, footage		nil.	209
Opencast, overburden removed	*cub yds.*	nil.	26,042
Tonnage mined		nil.	1,094
Copper precipitate produced	*tons*	3	1
Labour (average per day)		3	64

Work done at the Troodos mines of the Cyprus Chrome Co. Ltd. (Mining Lease and Prospecting Permits areas)

	First 6 months 1933.	First 6 months 1932.
Development, total footage	280	237
Tonnage mined	nil.	nil.
Tonnage exported	nil	nil.
Labour (average per day for 1 month)	—	61
Labour (average per day for 3 months)	48	—

Output of the Cyprus and General Asbestos Co. Ltd. (formerly Cyprus Asbestos Co. Ltd.), Amiandos

		First 6 months 1933.	First 6 months 1932.
Rock mined	*tons*	116,176	54,845
Rock treated	*tons*	23,826	12,056
Finished asbestos produced	*tons*	1,217	359
Finished asbestos exported	*tons*	1,158	767
Average daily labour (quarries only)		185	103
Average daily labour (all operations)		377	212

Minerals exported, other than those dealt with above, were as follows:

		First 6 months 1933	First 6 months 1932.
Terra umbra	*tons*	1,027	1,008
Terre verte	*tons*	nil	9
Gypsum, calcined	*tons*	5,625	3,708
Gypsum, raw	*tons*	949	1,583
Building stone	*cub. yds*	73	739

FEDERATED MALAY STATES

The Institute has received the following statement from the Director regarding the work carried out by the Geological Survey during the first half of 1933.

The Director returned from leave early in February and since then has been doing field-work on the occurrence of gold in the Raub District of Pahang.

The present cessation of prospecting for tin has given the mining geologist an opportunity to make considerable progress with the collection and examination of prospecting results.

The Assistant Geologist has completed the field-work of his examination of the neighbourhood of Sungei Siput North and is engaged on the preparation of his detailed report.

The Chemist, until he went on leave to England in May, was occupied with general analysis.

GOLD COAST

The Director of the Geological Survey has furnished the following report on the research work on raw materials carried out during the half-year ended June 30, 1933:

Gold.—A comprehensive survey of the gold occurrences of the Colony and Ashanti was commenced, and nearly 200 reef and banket prospects, together with a large number of alluvial prospects, were investigated. In many places encouraging results were obtained and details of these will be published in the Annual Report of the Geological Survey for 1932–33.

The survey has proved that the gold-quartz reefs are constantly associated with Upper Birrimian green-stones and phyllites where they are intruded by granite or porphyry of the Dixcove type. The manganese deposits also occur in these Birrimian greenstones and phyllites and many, if not most, of the diamondiferous occurrences are associated with the same rocks. As the auriferous conglomerates (banket) occur in the lower beds of the Tarkwaian System, which directly succeeds the Upper Birrimian rocks, it is clear that, with the help of geological maps, future prospecting for these minerals will be greatly facilitated.

Diamonds.—Diamonds were found in four tributaries of the Mamang river near Afoso and Ntranang (Western Akim District).

An alleged discovery of diamonds near Bopa, Sefwi District, was investigated. No diamonds were found in 100 pans of gravel, and the occurrence does not appear to be of economic importance.

Manganese.—A limited quantity of manganese ore, of fair to good quality, occurs in the vicinity of the lower Ankobra river near Esamang.

Geophysical Prospecting.—A few geophysical tests carried out by one of the geologists gave sufficiently encouraging results to justify much more work of this type in the search for buried mineral deposits.

NIGERIA

The Institute has received from the Director the following report concerning the work carried out by the Geological Survey during the first six months of 1933.

During the half-year under review the activities of the Department have been confined almost entirely to the investigation and development of minor water supplies. These operations have continued to meet with success and the number of wells sunk to water in all areas during this period totals 58.

When the roads opened, after the close of the wet season, sinking operations in Bornu Province were transferred from the Nguru area to one bordering the important

trade route from Geidam to Maiduguri. Owing to the necessity to reduce expenditure, when increased costs were to be expected consequent on the long motor haul of material from rail head, the diameter of shafts was reduced from four to three feet. Pressure rises were anticipated and found in the majority of wells in this area, however, and consequently, the quantity of water available is sufficient for all purposes. The experimental shaft at Jatori was carried down to 324 ft. and completed. A pressure rise of 36 ft. was obtained, and despite heavy and concentrated drawing it has not been found possible to reduce the depth of water below 9 ft.

In Sokoto City, a 4-in. hole was hand-drilled from the bottom of the 9-ft. diameter shaft, which taps ground water at 153, to a depth of 233 ft. Another aquifer was struck at this depth from which the water rises to the level of the ground water. It is hoped that this discovery will solve the water supply problem in Sokoto City. Sinking in the arid bush areas and in towns and villages in these districts has been steadily continued. During the period, 25 wells have been completed with an average depth of 100 ft., while 11 are now sinking. Progress has been made in the training of native personnel, although this has naturally been rather slower owing to the rapid strides made last year.

In Hadejia Emirate, operations were continued, but on a reduced scale. The wells which were in course of construction last year were completed and additional ones have been supplied where required. As they could be spared, sinking crews and materials were transferred to the neighbouring Gumel Emirate and work commenced there early in the year. Results in this Emirate have been satisfactory, several of the wells tapping pressure water.

In January last, shaft sinking was commenced in the northern portion of Katsina Emirate, where water supply conditions are badly in need of improvement. Although the greater part of the Emirate is underlain by crystalline rocks of various types, sediments probably of Eocene age are found in the north-east of the area selected by the Emir as the first requiring attention. Operations have been successful, and at the end of June, ten wells had been brought into production while nine were in the course of construction.

Geophysical investigations, using the electrical resistivity method, were carried out in the high areas of Ishan Division where the centres of population lie at least 1,000 ft. above the level of the River Niger, about 30 miles to the east. The beds are those of the Lignite group.

overlain by the Benin Sands which here contain abundant clay bands. Around the edge of the plateau are many springs, but they are at too low a level to be exploited without incurring a heavy expenditure. The resistivity method demonstrated the presence of high-level ground water bordering the Irrua swamp and a well was sunk to tap it. Unfortunately, the aquifer proved to be a clay and the rate of inflow is small. It is proposed to deepen this well in the hope of finding a free-yielding aquifer lower in the series.

A rapid reconnaissance survey was carried out of the area between the main railway line and the Dahomey border. Kaolin, first reported by Kitson in 1907 from Meko, is found to be widely distributed and to occur at several horizons. Some of it is due to the decomposition of gneiss in situ, while some occurs in beds of sedimentary origin. Thirteen outcrops, varying in thickness from 13 ft. downwards, were discovered and samples from the best of these have been sent to the Imperial Institute for examination.

Interest in gold is being maintained and the monthly output is steadily increasing. The returns show a total of 6,318 oz. of metal won for the first half-year. Topographical maps on which the geology is being superimposed will shortly be available, together with a brief explanatory pamphlet.

TANGANYIKA

The following report, furnished by the Director of the Geological Survey, relates to the work carried out during the half-year ended June 30, 1933.

The field season in Tanganyika Territory is from May to November, so that during the greater part of the period under review duties were carried out in office and laboratory, and such field work as was undertaken was of minor importance and was confined to the neighbourhood of the departmental headquarters at Dodoma.

The Director, Dr. E. O. Teale, was on leave from January 3, 1933, to May 29, 1933, during which time Mr. F. B. Wade, Senior Assistant Geologist, acted for him.

Field work, carried out at suitable intervals between the rains by Messrs. G. M. Stockley and F. Oates, consisted mainly of studies in connection with the Dodoma Series, an ancient, highly metamorphosed sedimentary formation, which has been provisionally assigned to the Upper Group of the Basement Complex. This series, consisting of schists and ferruginous quartzites, is well exposed a few miles south of Dodoma, where it forms a

belt of practically vertical strata less than two miles in width, striking from 270° to 315° (magnetic bearings). The country surrounding Dodoma consists of deeply eroded grey biotite-granite, showing local flow-banding and streakiness due to contamination, but no marked foliation. The occurrence therein of schist rafts lithologically similar to the Dodoma Series suggests that they are perhaps detached and foundered roof-pendants.

There is some mineralisation in the neighbourhood of the contact of the granite and schist, and the occurrence of both gold and corundum has been noted. Gold occurs in small veins and stringers, and the gravels of many of the small watercourses descending from the rocky hills to the peneplain below show some concentration of the metal, although so far nothing of economic value has been discovered, nor are the indications particularly promising.

Several small deposits of corundum have been discovered, generally in the vicinity of pegmatite dykes. The mineral, which is unfortunately of inferior quality, forms large crystals in mica-schist.

Some work has also been done about 70 miles north of Dodoma in connection with an occurrence of nickel discovered in 1931 by a prospector. The nickel is contained in a granular magnetite, which carries up to 8 per cent. of the metal, and its source has now been traced to a belt of serpentinised and silicified olivine- and enstatite-bearing ultrabasic rocks, at least 10 miles in length, along the northern flanks of the Chenene Hills.

The well-boring branch of the Department continues to function with success and its services have been in continuous demand by sisal and coffee planters, as well as other members of the general public, who are beginning to appreciate the value of deep-seated, reliable supplies which are obtainable only by boring.

In the laboratory, the Chemist and Petrologist, Mr. Oates, was kept very fully occupied, the demand for gold assays, chemical analyses and petrographical work from outside sources being unusually high. Despite this fact, some time was found for purely departmental work of various kinds, including rock analysis.

The retrenchment on grounds of economy of the European Clerk and the secondment of Dr. Grantham, Assistant Geologist, to British Guiana, has thrown much extra work upon the remainder of the Staff. Notwithstanding this, plans for the coming field season are ambitious, and include detailed geological surveys (in liaison with the Survey Department) of two of the principal gold areas of the Territory—the Lupa Goldfield

in the Mbeya District of the South-West Highlands, and the Musoma area, south of Lake Victoria.

Among the numerous official publications issued by the Department during 1933 were (1) a description of the limestone deposits of Tanganyika, published as *Bulletin No.* 4, and (2) a coloured provisional geological map of Tanganyika on a scale of 1 : 2,000,000, published with an explanatory outline of the pure and economic geology of the Territory as *Bulletin No.* 6.

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The Empire Tobacco Industry. England: I. Experiments. II. Policies and Difficulties. By J. Robotham. *Empire Production* (1933, No. 201, 139–146; No. 202, 159–160) Gives an account of the present position of tobacco growing in England.

The Empire Tobacco Industry in South Africa · General Conspectus. By P. Koch and W. J. Pretorius *Empire Production* (1933, No. 200, 111–114).

Flue Curing and Grading of Tobacco in the Guntur District. *Madras Agric Journ* (1933, **21**, 305–312).

How is the Leaf Prepared to Make our Cigarettes. By L. H. Zeun. *Tobacco* (1933, **95**, No. 17, 11–12 14).

The Smoking Qualities of Australian Tobacco Preliminary Report. By C. M. Stagg. *Bull. No.* 2, *Australian Tobacco Investigation.* Pp. 30, 9½ × 6. (Melbourne: Government Printer, 1933.)

Drugs

Indagini sui Prodotti Erboristici dei Mercati Abissini in Etiopia. By P. Rovesti. *Riv. Italiana delle Essenze, dei Profumi e delle Piante Officinali* (1933, **15**, 179–191). Deals with the production of various herbs and drug plants in Abyssinia

Indian Artemisias. By S Krishna and B S. Varma. *Quart. Journ. Pharm.* (1933, **6**, 23–30).

Contribution à l'Étude Chimique des Plantes à Huile Chaulmoogrique du Congo Belge. I. Le *Caloncoba Welwitschii* (Oliv.) Gilg. II. *L'Hydnocarpus Wightiana* Bl. III. *L'Hydnocarpus anthelmintica* Pierre. By L. Adriaens. Pp. 22 + 3 + 6, 10 × 6½. (Brussels: Institut Royal Colonial Belge.) Three reprints from *Bulletin de l'Institut Royal Colonial Belge*, 1932, **3**, No 2, and 1933, **4**, No. 1.

Seventieth Annual Report of the Government Cinchona Plantations and Factory in Bengal for the year 1931–32. Pp 26, 9¾ × 6¼. (Calcutta: Bengal Secretariat Book Depot, 1932.) Price 12 annas or 1s. 3*d*.

Quelques Considérations sur des Recherches Biologiques à Effectuer pour Intensifier la Culture et l'Utilisation des Essences à Quinquina. By E. de Wildeman. Pp. 27, 10 × 6½. (Brussels: Institut Royal Colonial Belge.) Reprint from *Bulletin de l'Institut Royal Colonial Belge* (1933, **4**, No. 1). Discusses the possibilities of cinchona with special reference to the Congo Belge.

Control of *Alternaria* Blight of Ginseng with Bordeaux Mixture and Injuries Accompanying its Use. By H. A. Runnels and J. D. Wilson. *Bull.* 522, *Ohio Agric. Exper. Sta.* Pp. 16, 9 × 6. (Wooster: Agricultural Experiment Station, 1933.)

La Coltivazione del Papavero da Oppio in Italia. *Riv. Italiana delle Essence, dei Profumi e delle Piante Officinali* (1933, **15**, 131–135). Cultivation of the opium poppy in Italy.

Papaw and its Commercial Possibilities. By M. Llanos. *Proc. Agric. Soc., Trinidad and Tobago* (1933, **33**, 83–90).

Papaw Selection. By J. D. J. Hofmeyer. *Farming in S. Africa* (1933, **8**, 157–158).

Contribution à l'Étude Histologique et Chimique du *Sterculia Bequærti* De Wild. (*Sterculia Tragacantha* Lindl var. *cruciata* Vermœsen). By L. Adriaens, E. Castagne and S. Vlassov. Pp. 111, 10 × 6½. (Brussels: Institut Royal Colonial Belge, 1933.)

Miscellaneous Agricultural Products

Production of Absolute Alcohol by the Hiag Process. *Intern. Sugar Journ.* (1933, **35**, 266–268).

The Production of Casein Plastics. *Indust Chem.* (1933, **9**, 193–197). Consists of a short description of the works of Erinoid Ltd., at Stroud, Glos.

The Production and Uses of Solid CO_2. By H. G. Littler. *Journ. Soc. Chem. Indust.* (1933, **52**, 533–537).

Furfural, an Industrial Raw Material and Solvent. *Journ. Soc. Chem. Indust.* (1933, **52**, 608–612). Deals with its manufacture and use.

The Vegetable Ivory Palm (*Hyphæne ventricosa*). By G. M. McGregor. *Rhodesia Agric. Journ.* (1933, **30**, 289–291).

Linoleum. An Account of Modern Methods of Manufacture. By F. Fritz. *Paint Manufacturer* (1933, **3**, 130–134).

Soap Making as a Cottage Industry in Bihar and Orissa. By A. S. Khan. *Bull. No.* 5, *M.I.S., Dept. Indust., Bihar and Orissa.* Pp. 46, 10 × 7. (Patna: Superintendent, Government Printing, 1933.) Price Re. 1.

Chemical and Physical Properties of Sweet Potato Starch. By F. H. Thurber. *Indust. Eng. Chem.* (1933, **25**, 565–568).

Manufacture of Starch from Jowar. By M. S. Patel and K. P. Shah. *Bull. No.* 7, *Dept. Indust., Bombay.* Pp. 9, 9½ × 6. (Bombay: Superintendent, Government Printing and Stationery, 1933.) Price 1 anna or 1*d.*

Livestock and Animal Products

Report on the Marketing of Livestock in Scotland. *Department of Agriculture for Scotland.* Pp. 129, 9¾ × 6. (London: H.M. Stationery Office, 1933.) Price 1*s.*

Administration Report of the Government Veterinary Surgeon, Ceylon, for 1932. Pp. 12, 9¾ × 6½. (Colombo: Government Record Office, 1933.) Price 15 cents.

Points for Consideration in Relation to the Improvement of Livestock in India. By A. Oliver. *Agriculture and Livestock in India* (1933, **3**, 205–210).

Annual Report of the Civil Veterinary Department, Punjab, for the year 1931–1932. Pp. 61, 9¾ × 6½. (Lahore: Superintendent, Government Printing, 1933.) Price Rs. 2–8 or 3*s.* 9*d.*

Annual Report of the Veterinary Department, Federated Malay States, for the year 1932. Pp. 9, 9½ × 6. (Kuala Lumpur: Government Press, 1933.) Supplement to the *F.M.S. Gazette,* June 16, 1933.

Annual Report of the Veterinary Department, Nigeria, for the year 1931. Pp. 27, 13½ × 8. (London: Crown Agents for the Colonies, 1933.) Price 2s. 6d.

Live Stock Diseases Report No. 8. Recording the Control Work of the Department of Agriculture, New South Wales, during the year ended June 30, 1932. Pp. 13, 9 × 6. (Sydney: Government Printer, 1933.)

Fattening Bullocks for Export. By A. E. Romyn. *Rhodesia Agric. Journ.* (1933, **30**, 356–364).

The Preservation of Meat by Means of Refrigeration. By D. J. Schutte. *Farming in S. Africa* (1933, **8**, 133–135).

Annual Report of the National Institute for Research in Dairying, University of Reading, for 1932. Pp. 70, 9½ × 7½. (Reading: University of Reading, 1933.)

Dairy Produce Supplies in 1932 (including Poultry and Pig Products). *Empire Marketing Board Publication No.* 66. Pp. 124, 9¾ × 7¼. (London: H.M. Stationery Office, 1933.) Price 1s.

British Breeds of Milch Goats. By S. Leigh Hunt. *Journ. Min. Agric.* (1933, **40**, 141–145).

Some Economic Aspects of the Scottish Sheep Industry. By A. H. H. Fraser. *Scottish Journ. Agric.* (1933, **16**, 152–160).

The Breeding of Coloured Sheep. By J. A. Fraser Roberts. *Scottish Journ. Agric.* (1933, **16**, 184–191).

Some Observations on the Calcium and Phosphorus Metabolism of the Sheep. By I. J. Cunningham. *New Zealand Journ. Sci. and Tech.* (1933, **14**, 281–287).

The Sheep Blowfly Problem in Australia. Report No. 1 by the Joint Blowfly Committee appointed by the Council for Scientific and Industrial Research and the New South Wales Department of Agriculture. *Pamphlet No.* 37, *Counc. Sci. Indust. Res., Australia.* Pp. 136, 9½ × 6. (Melbourne: Government Printer, 1933.)

Control of the Sheep Tick on Hill Pastures. A Review of the Possibilities, with some Experimental Data. By J. Macleod. *Trans. Highland and Agric. Soc., Scotland* (1933, **45**, 114–127).

Veterinary Research Report No. 6, Part III (December 1931). *Department of Agriculture, New South Wales.* Pp. 42, 9½ × 6. (Sydney: Government Printer, 1933.) Deals mainly with diseases of sheep.

Pig Raising on the Wheat Farm. By A. S. Harnett. *Agric. Gaz., N.S. Wales* (1933, **44**, 425–429).

Feeding Pigs for Bacon Production. By J. A. du Plessis. *Farming in S. Africa* (1933, **8**, 259–261).

Table Poultry Production with a Section on Battery Brooding. *Bull. No.* 64, *Min. Agric. and Fisheries.* Pp. 37, 9½ × 6. (London: H.M. Stationery Office, 1933.) Price 1s.

The Poultry Industry of India. By R. L. Pandey. *Madras Agric. Journ.* (1933, **21**, 202–208).

Bulkiness of Food as a Factor in Poultry Feeding. By T. Shaw and E. A. Fisher. *Journ. Min. Agric.* (1933, **40**, 327–337).

Diseases of Poultry and Notes on Poultry Rearing in Malaya. By H. D. Meads. *Malayan Agric. Journ.* (1933, **21**, 249–264).

Turkey Raising. By S. J. Marsden and A. R. Lee. *Farmers' Bull. No.* 1409 (*Revised*), *U.S. Dept Agric.* Pp. 38, 9 × 6. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1933.) Price 5 cents.

Rabbits for Fur and Flesh. *Advisory Leaflet No.* 161, *Min. Agric. and Fisheries.* Pp. 4, 8½ × 5½. (London: H.M. Stationery Office, 1933.) Price 1d.

Hints to Beginnings in Beekeeping. By H. Hacker. *Queensland Agric. Journ.* (1933, **39**, 208–212).

Fifty-First Annual Report of the Fishery Board for Scotland, being for the year 1932. Pp. 95, 9½ × 6. (London: H.M. Stationery Office, 1933.) Price 2*s*.

The Marine Fisheries of the Bombay Presidency. By H. T. Sorley. Pp. 174, 9 × 6. (Bombay: Superintendent, Government Printing and Stationery, 1933.) Price 13 annas or 1*s* 4*d*.

Administration Report of the Madras Fisheries Department for the year 1931–32. Pp. 88, 10 × 6¼. (Madras: Superintendent, Government Press, 1933.) Price 8 annas.

Annual Report of the Department of Marine and Fisheries, Newfoundland, for the year 1932. Pp. 29, 8¾ × 5½. (St. John's: Department of Marine and Fisheries, 1933.)

Recent Work on Methods of Dealing with Insect Pests in Hides and Skins. By M. E. Robertson. *Leather World* (1933, **25**, 582–583).

Some Notes on Beetles and their Damage to Hides and Leather. By F. O'Flaherty and W. T. Roddy. *Journ. Amer. Leather Chem. Assoc.* (1933, **28**, 298–306).

Sugli Effetti dei Danni Causati dagli Acaridi sul Cuoio Finito By A. Gausser. *Boll. Uff. R. Stazione Sperimentale per l'Indust delle Pelli e delle Materie Concianti* (1933, **11**, 230–237) Damage caused to hides and skins by mites.

The Problem of Deterioration and Preservation of Leather on Storage. By R. Faraday Innes. *Journ. Fed. Curriers, Light Leather Tanners and Dressers, Inc.* (1933, **14**, 91–94).

The Tanning of Leather. *Indust. Chem* (1933, **9**, 154–158). Deals with the preparation of leather from the untreated hides.

Riconoscimento e Classificazione delle Pelliccie Mediante l'Analisi Microscopica delle Loro Sezioni Trasversali By B. Avenati-Bassi *Boll. Uff. R. Stazione Sperimentale per l'Indust. delle Pelli e delle Materie Concianti* (1933, **11**, 264–296). The identification of various skins by the microscopic study of their cross sections

FORESTRY

General

Report on Forest Administration in Burma (excluding the Federated Shan States) for the year ending March 31, 1932. Pp 279, 9¾ × 6½. (Rangoon: Superintendent, Government Printing and Stationery, 1933.) Price Rs. 3–8 or 5*s*. 3*d*.

Administration Report of the Acting Conservator of Forests, Ceylon, for 1932. Pp. 14, 9¾ × 6. (Colombo. Government Record Office, 1933.) Price 15 cents.

Annual Report of the Forest Administration in Cyprus for the year 1932. Pp. 44, 8¾ × 6. (Nicosia: Conservator of Forests, 1933) Price 1*s*.

Report on Forest Administration in the Andamans, for the year 1931–32. Pp. 80, 9½ × 6¼. (Delhi: Manager of Publications, 1933.) Price Rs. 10–6 or 17*s*.

Annual Progress Report on the Forest Administration in the Presidency of Bengal for the year 1931–32. Pp. 119, 9¾ × 6½. (Calcutta: Bengal Secretariat Book Depot, 1932.) Price Re. 1–13 or 3*s*.

Administration Report on the Forest Department of the Central Provinces for the year ending March 31, 1932. Pp. 22, 9½ × 6¼. (Nagpur: Government Printing, 1932.) Price Re 1.

Report on the Forest Administration of the Central Provinces for the year ending March 31, 1932. Statements. Pp. 82, 9½ × 6¼. (Nagpur: Government Printing, 1933.) Price Re. 1–8.

Administrative Report of the Forest Department of the Madras

Presidency for the year ending March 31, 1932. Pp. 220, 9¾ × 6. (Madras: Superintendent, Government Press, 1933.) Price Rs 1–14.

Annual Report of the Forest Department, North Borneo, for the year 1933. Pp. 15, 12½ × 8½. (Sandakan: Government Printing Office, 1933.)

The Trees of New South Wales. By R. H. Anderson. ***Department of Agriculture, New South Wales.*** Pp. 244, 9 × 6. (Sydney: Government Printer, 1932.) Price 5s. Deals with the native and introduced trees of New South Wales, their botanical features, distribution, soil requirements, general usefulness and cultivation, and the utility of the various species from the farmers' and the pastoralists' points of view. A key by which any particular specimen may be identified is given.

Notes sur un Programme de Reforestation au Kivu. By J. Lebrun. *Bull. Agric., Congo Belge* (1932, **23**, 245–360).

Studies of Scottish Moorlands in Relation to Tree Growth. *Forestry Commission Bull. No.* 15. Pp. 128, 9½ × 6. (London: H.M. Stationery Office, 1933.) Price 2s. 6d.

Leaf Cast (*Meria laricis* Vuill.) of Larch. *Leaflet No.* 21, *Forestry Commission.* Pp. 6, 9¾ × 6. (London: H.M. Stationery Office, 1933.)

Timbers

The Timber Problem. Its International Aspects. *League of Nations Publication, Series II, Economic and Financial,* 1932, II, B. 6. Pp. 51, 10½ × 8. (Geneva: Publication Department of the League of Nations, 1932.) Price 1s. 6d.

Timber Borers. By R. Veitch. *Queensland Agric. Journ.* (1933, **39**, 122–127). Descriptions with suggested methods of control of several timber borers.

Dry Rot in Wood. *Bull. No.* 1 (*Second Edition*), *For. Prod. Res., Dept. Sci. Indust. Res.* Pp. 34, 9½ × 6. (London: H.M. Stationery Office, 1933.) Price 1s.

The Mechanical Properties of Canadian Woods together with their Related Physical Properties. By G. H. Rochester. *Bull.* 82, *Forest Serv., Dept. Interior, Canada.* Pp. 88, 9¾ × 6¾. (Ottawa: King's Printer, 1933.)

The Longitudinal Variation of Timber during Seasoning. By M. B. Welch. *Journ. and Proc. Roy. Soc., New South Wales* (1932, Pt. II, 492–497).

Thirteenth (Interim) Report of the Committee of the Institution of Civil Engineers on the Deterioration of Structures in Sea Water. Pp. 59, 9¾ × 6. (London: H.M. Stationery Office, 1933.) Price 1s. 6d.

South African Grown Timber. Various Uses for Well-Seasoned Wood. By N. B. Eckbo. *Farming in S. Africa* (1933, **8**, 191–192).

Chemical Utilization of Wood. By H. K. Benson. *Report of the National Committee on Wood Utilization, U.S. Dept. Commerce.* Pp. 151, 9 × 6. (Washington D.C.: Superintendent of Documents, Government Printing Office, 1932.) Price 15 cents. Deals with the physical properties of wood, its chemical composition, sawdust and ground wood products, wood processing and manufactured products, chemical wood pulp, wood distillation, tannin and wood extracts, carbohydrates from wood and sulphite waste liquor.

The Survival of Wood Distillation. By M. Schofield. *Indust. Chem.* (1933, **9**, 201-203). An account of the present position of wood distillation.

The Manganese Content of some Australian Timbers. By W. E. Cohen and A. B. Jamieson. *Journ. Counc. Sci. Indust. Res., Australia* (1933, **6**, 116–119).

Leaching Tests on Water Soluble Wood Preservatives. By C. Greaves. *Circ.* 36, *Forest Serv., Dept. Interior, Canada.* Pp. 15, 9¾ × 6¾. (Ottawa: King's Printer, 1933.)

L'Industrie Algérienne des Ebauchons de Pipes. By P. Lafuente. *Bull. Econ., Algeria* (1933, **2**, 521–526). An account of the Algerian industry in briar pipe blanks.

Experiments in Cutting and Seasoning Keruing for Export. By F. H. Landon. *Malayan Forester* (1933, **2**, 72–75).

Properties of Mansonia (*Mansonia altissima* A. Chev.) from Nigeria. *Investigation* 13, *Project* 22, *For. Prod. Res. Lab., Dept. Sci. Indust. Res.* Pp. 10, 9½ × 7½. (Princes Risborough, Bucks: Forest Products Research Laboratory, 1933.)

Properties of Munyama (*Khaya anthotheca* C. DC.) from Uganda. Interim Report. *Investigation No.* 1, *Project* 24, *For. Prod. Res. Lab., Dept. Sci. Indust. Res.* Pp. 35, 9½ × 7½. (Princes Risborough, Bucks; Forest Products Research Laboratory, 1933.) Mimeographed copy.

Properties of Musisi (*Mæsopsis Eminii* Engl.) from Uganda. *Investigation* 16, *Project* 22, *For. Prod. Res. Lab., Dept. Sci. Indust. Res.* Pp. 12, 9½ × 7½. (Princes Risborough, Bucks: Forest Products Research Laboratory, 1933.) Mimeographed copy.

Studies in the Decomposition of Timber under Industrial Conditions. Greenheart. By E. A. Rudge. *Journ. Soc. Chem. Indust.* (1933, **52**, 283T–285T).

The Incidence of Borer Attack on Some Specimens of Meranti. By E. C. Foenander. *Malayan Forester* (1933, **2**, 57–60).

Red Stain in Jack Pine. A Comparative Study of the Effect of *Trametes Pini* and a second Red-staining Fungus on the Strength of Jack Pine. By C. W. Fritz and G. H. Rochester. *Circ.* 37, *Forest Serv., Dept. Interior, Canada.* Pp. 15, 9¾ × 6¾. (Ottawa: King's Printer, 1933.)

Gums and Resins

Malayan Damars. By T. H. Barry. *Paint Manufacture* (1933, **3**, 160–163).

Damar-Onderzoek in West Borneo. By J. P. Schuitemaker. *Tectona* (1933, **26**, 230–264). An account of a large number of damars, their occurrence, utilisation and trade.

Notes on the Use of *Schleichera trijuga* (Kusum) in Lac Cultivation. Pruning and Cropping. By D. Norris. *Bull. No.* 15, *Indian Lac Res. Inst.* Pp. 19, 9¾ × 7¼. (Namkum, Ranchi: Indian Lac Research Institute, 1933.) Price Re. 1–4.

Nature and Constitution of Shellac. V. Effect of Small Amounts of Certain Impurities. *Indust. Eng. Chem.* (1933, **25**, 550–554).

The "Heat Curing of Shellac." Part I. The "Life under Heat." *Bull. No.* 14, *Indian Lac Res. Inst.* Pp. 9, 9¾ × 7¼. (Namkum, Ranchi: Indian Lac Research Institute, 1933.) Price Re. 1–8.

Tanning Materials

Per l'Utilizzazione Integrale della *Cæsalpinia spinosa* (Mol.) Kuntze. By A. Castiglioni. *Boll. Uff. R. Stazione Sperimentale per l'Indust. delle Pelli e delle Materie Concianti* (1933, **11**, 314–319). The use of the various parts of the tree *Cæsalpinia spinosa* in tanning.

Quebracho. A Review of its Various Forms. By W. Vogel. *Leather Trades Review* (1933, **66**, 558–559).

Annual Report of the Natal Wattle and Timber Growers' Association for the year 1932. Pp. 5, 13½ × 8. (Pietermaritzburg: Wattle and Timber Growers' Association, 1933.)

NOTICES OF RECENT LITERATURE

Books for review should be addressed to "The Editor," Bulletin of the Imperial Institute, South Kensington, London, S.W.7.

ECONOMIC AND SOCIAL GEOGRAPHY. By Ellsworth Huntington, Frank E. Williams and Samuel van Valkenburg. Pp. xi + 630, 9 × 6. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1933.) Price 23*s*.

The wide scope of this volume is well indicated in the following extract from the Preface. "A continuous thread of geographic reasoning runs through the whole of this book. It begins with a section on the major factors of geographic environment and the principles which govern their relation to plants, animals and man. Climate naturally comes first because it is the most widespread, pervasive, and variable of the factors. Relief, however, is fully treated in relation not only to transportation but also to vegetation and human responses. Soils are treated equally fully; recent discoveries and personal observations in many lands have made it possible to set forth the principles which govern their world-wide distribution and influence with a logical completeness which has surprised the authors themselves."

A detailed description of the contents is not possible here, but it may be said that the book should admirably serve its purpose as a text-book for students, in view of its clear and systematic arrangement, interesting style, copious supply of maps and diagrams, and other features, all of which serve to enhance its practical value.

THE JOURNAL OF THE SOUTH-EASTERN AGRICULTURAL COLLEGE, No. 32, 1933. Edited for the College by S. Graham Brade-Birks, M.Sc.(Manc.), D.Sc.(Lond.), F. Pp. 234, 10½ × 7¼. (Wye, Kent: 1933.) Price 7*s*. (post free); to residents in Kent and Surrey, 4*s*. (post free).

This volume contains a series of valuable papers by members of the College staff, covering a wide field of agricultural subjects. Some of them deal with matters relating essentially to local (or, at least, English) farming conditions, but among those most likely to be of interest to overseas readers the following may be mentioned: Photography as a Help in the Examination of Cattle Foods—Structure of the Pod and Seeds of *Canavalia* spp.;

Further Investigations into Penetrability of Steel Points and Soil Consolidation ; The Suffolk Sheep—a Survey of the Breed ; The Southdown Sheep ; The Treatment of Poultry Experimental Data by the Analysis of Variance Method ; Soil Monoliths ; The Field Examination of the Natural Drainage of Soils ; A Defence of the "Soil-Series" and American Methods of Soil-Classification.

The publication as a whole is excellently produced, and is illustrated by numerous diagrams and photographs. Not only the articles mentioned above but the other contributions also should prove helpful and instructive to practical agriculturists throughout the Empire.

A NOTE-BOOK OF TROPICAL AGRICULTURE. Compiled by R. Cecil Wood, M.A., Dip.Agric.(Cantab.). Pp. 140, $6\frac{3}{4} \times 4\frac{1}{4}$. (Trinidad, B.W.I.: The Imperial College of Agriculture, 1933.) Price 5*s.*

In this little volume Professor Wood has brought together in convenient form a great deal of information of interest and use to all engaged in agriculture in tropical countries. Amongst the varied contents may be mentioned weights and measures of different countries, useful directions for mensuration and surveying, the construction of buildings and roads and the use of agricultural machinery. A good and concise account of modern views on soils, contributed by Prof. F. Hardy, and of manures, are followed by a résumé of information on many tropical crops. The latter section is rather lacking in balance, thus for example whilst many comparatively unimportant millets and other food crops are treated in detail, cassava is dismissed with the comment that it is "planted from cuttings." Information on stock includes data on foods and feeding with model rations and cost, notes on the principal domesticated animals of the tropics, veterinary notes, and dairying.

Recipes for a few useful fungicides, insecticides, etc., information regarding Empire Agricultural Institutions, and notes on the area, population and chief exports of the Colonies of the Empire complete the volume.

The work will doubtless be of use to many, and the blank pages with which it is interleaved will allow anyone to add additional items in their appropriate places for future reference. The author states that he would welcome any corrections and additions. With such assistance this book might in the course of an edition or two develop into a still more useful pocket-book of reference for the tropical agriculturist.

PRINCIPLES OF FRUIT PRESERVATION. Jam Making, Canning and Drying. By T. N. Morris, M.A. Being Volume Six of a Series of Monographs on Applied Chemistry, under the Editorship of E. Howard Tripp, Ph.D. Pp. xiii + 230, 8½ × 5½. (London: Chapman & Hall, Ltd., 1933.) Price 15*s.*

This volume by Mr. Morris of the Cambridge Low Temperature Research Station is a very welcome addition to the literature on the canning and drying of fruit and the manufacture of jams.

The Introduction and the concluding Part IV of the book deal with general matters, such as the composition of the chief fruits, their colouring matters and the causes and remedies for discolouration in fruit products, also the occurrence of vitamins in canned and dried fruits and in jams.

The bulk of the book is divided into three Parts, dealing respectively with Jams and Fruit Jellies, Canning of Fruit, and Dried Fruits.

In Part I, the pectic substances are fully treated, both historically and in the light of modern practice. The preparation of pectin is described and detailed directions are given for the manufacture of jams under conditions of adequate chemical control.

In Part II, after a general account of the processes of canning, special attention is paid to the important question of spoilage, the causes to which it may be due and the measures necessary to prevent such mishaps.

Part III describes the general principles of dehydration, and the principal measures employed in drying fruits and subsequently in storing them, with special reference to the prevention of insect attack.

The author in his preface states that the book has behind it nine years of research and factory experience. He has also drawn on information otherwise available, as indicated by the copious references appended to each chapter. The book will undoubtedly take its place as a standard work of reference on the important subjects with which it deals.

THE MEDICINAL AND POISONOUS PLANTS OF SOUTHERN AFRICA, being An Account of their Medicinal Uses, Chemical Composition, Pharmacological Effects and Toxicology in Man and Animal. By John Mitchell Watt, M.B., Ch.B. (Edin.), and Maria Gerdina Breyer-Brandwijk, Phil. doct. (Utrecht), Apotheker (Utrecht). Pp. xx + 314, 10 × 7½. (Edinburgh: E. and S. Livingstone, 1932.) Price 25*s.*

This work is a most valuable compilation of all available information relating to the medicinal and poisonous plants

of South Africa. As the authors point out in their Preface, that country, with its wealth and variety of flora, has accumulated through the centuries a great mass of popular remedies, to which Bushman, Hottentot, Bantu and White man have each contributed their share. These remedies are in common use, but much of the folk medicine of the South African native tribes is vanishing before the advancing tide of civilisation with its synthetic medicines. In the authors' opinion there is little doubt that it will have disappeared largely in the course of a few years, and for this reason they considered that the recording of it was a matter of urgency. Much work has been done on the chemistry, pharmacology and toxicology of the plants in question, but there are still many gaps in our knowledge and the volume will serve a very useful purpose in drawing attention not only to the recorded results but also to the directions in which new work is needed.

The plants discussed are arranged under their natural orders, and at the end of each section is a list of references to literature, which adds very greatly to the value of the book. The indexes have been compiled with special care with a view to making reference to a subject as easy as possible, and occupy nearly 90 pages. They comprise indexes of botanical names, of English and Africaans names and of native names, and also one of active principles giving the systematic names of the plants in which each occurs.

Report of the Forest Products Research Board for the Year 1931. Department of Scientific and Industrial Research. Pp. vii + 51, $9\frac{3}{4} \times 7\frac{1}{4}$. (London: His Majesty's Stationery Office, 1932.) Price 3*s*. 6*d*.

The Report of the Forest Products Research Board for 1931, together with the corresponding Report of the Director of Forest Products Research, became available in the early part of the present year. In reviewing the work of the Forest Products Research Laboratory at Princes Risborough the Board refer to the preliminary and often empirical nature of the investigations of the earlier years of the Laboratory's activities, and mention as examples of the fundamental work now in hand the researches on the part played by wood structure in influencing the penetration of antiseptics during preservative treatment, and the endeavour to establish the principles that should govern technique in the machining of different kinds of timber. The work of the Laboratory during the year covered a wide and interesting field. Reference is made to the research progressing in the new

experimental building erected for the express purpose of studying the problems offered by the dry-rot fungus and the death-watch beetle, which can now be studied under conditions affording great advantages to the investigators.

The reconditioning of collapsed timber is a subject of considerable practical importance. The method suggested by the Australian Forest Products Laboratory in connection with the treatment of collapsed Tasmanian oak, which was successfully adopted at Princes Risborough in 1930 for dealing with parcels of that timber, has been employed with satisfactory results in the case of home-grown elm, beech and ash which showed warping, cupping and bowing.

Continuation of the survey of insects attacking timber led to important conclusions regarding the infestation of timber by the *Lyctus* powder-pest beetles. It would appear that this trouble can no longer be ascribed solely to the importation of infested timber from abroad, for *Lyctus* has now become established in this country and occurs quite as frequently in such home-grown timbers as ash, oak and walnut as in imported timbers. The solution of the problem cannot therefore be found in legislation to prevent the importation of infested timber. The Laboratory has demonstrated a method of steam sterilisation for infected timber.

Reference is also made to the work of the Empire Timbers Committee, which indicates that with appropriate measures the Empire might become almost, if not entirely, self-supporting in hardwoods, while there is room for a much increased consumption of Canadian softwoods within the Empire. The factors which at present militate against the extension of the market for Empire woods are discussed.

HYDROGEN ION CONCENTRATION AND ITS PRACTICAL APPLICATION. By Frank L. LaMotte, William R. Kenny and Allen B. Reed. Pp. vii + 262, $9\frac{1}{2} \times 6\frac{1}{4}$. (London: Baillière, Tindall & Cox, 1932.) Price 20s.

This book is written especially for those who are concerned primarily with the practical application of hydrogen ion concentration determination and who do not require a learned treatise upon the subject. With this end in view the section dealing with the fundamental principles has been kept as short as possible and has been written in simple language. Of the two general types of methods for determining *p*H values, i.e. potentiometric and colorimetric, the latter only is described as it is the one more usually employed, but the discussion also

includes reference to instances where colorimetric measurements do not agree with the electrometric values.

The greater part of the book is devoted to the practical application of hydrogen ion determinations in industry and science, and in this connection a large number of different industries are dealt with. In these fourteen chapters, the authors have condensed, into workable schedules, a vast amount of data derived from practical experience. The methods outlined are simple and effective and, together with the data presented, form a useful guide for routine and research work. A useful feature of the book is the lists of selected references to literature dealing with the various subjects discussed.

FERTILISERS AND CROP PRODUCTION. By Dr. Lucius L. Van Slyke, Ph.D. Pp. xiv + 493, 9 × 6. (New York: Orange Judd Publishing Company, Inc., 1932.) Price $4·00.

This book, the author of which was for many years chemist at the New York Agricultural Experiment Station, is written with a view to the needs not only of students in agricultural colleges but also of the practical farmer whose main concern is with the immediate production of crops on a profitable basis. Although the author treats largely of the actual application of fertilisers, he is also deeply concerned with the numerous other vital factors which influence response of the crop to the nutrient materials supplied to it.

The book is divided into five parts, each containing several chapters. The first part deals in an introductory manner with the factors affecting soil fertility and gives a simple outline of the elementary facts of chemistry needed for comprehension of the rôle played by the various elements and compounds essential to plant nutrition. The specific importance of the different elements and their distribution in the separate portions of various crops are treated at some length. Part II is concerned with the functions and physical properties of the soil—its relation to the roots of plants, the main inorganic and organic constituents usually present, relationships between water, soil and crops, mode of absorption of nutrients by plants and the importance of soil micro-organisms.

In the third section, the various materials used as direct plant-foods and as indirect fertilisers and soil amendments are dealt with in detail, the composition, origin, method of manufacture, advantages and disadvantages of practically all the well-known artificial fertilisers being indicated. The conservation and use of the

materials of manurial value which can be produced on the farm itself are described and there is a comprehensive chapter on green manuring.

The fourth part of the book enumerates the factors which must be considered in selecting fertilisers and the most effective method of use. More emphasis might usefully have been laid on the limiting effect of a marked deficiency of any one essential element and on the necessity for well-balanced proportions in fertiliser mixtures. The possibility of the lack of one of the less common elements, such as manganese, might also have been considered.

This section also includes information on fertiliser laws in the United States, methods of calculating cost per unit of actual plant food and the question of home-mixed versus commercial fertilisers. The author appears to favour the former, largely on account of the additional information as to ingredients which is often thus readily available to the farmer. The principles underlying the rotation of crops and examples of their practical application are also given.

The final section of the book deals with the application of fertilisers to the growing of specific crops and contains a large amount of valuable information in somewhat condensed form. Data for a number of useful fertiliser mixtures are given, as well as information relating to amount of seed, general cultural treatment and most favourable soil and climatic conditions for the growth of most of the crops of economic importance in the United States.

The book as a whole forms a storehouse of useful and essentially practical information for farmers in America or in other countries with similar climatic conditions. Unfortunately the death of the author occurred between completion of the manuscript and publication, and this is probably the reason why the book is marred by evidences of lack of care in editing and proof-reading.

THE GENESIS OF THE DIAMOND. By Alpheus F. Williams, B.Sc. Vol. I, pp. 1–352; Vol. II, pp. 353–636, 9¾ × 7¼. (London: Ernest Benn, Ltd., 1932.) Price 84s.

It is unusual in these days to find books devoted to scientific subjects produced in such magnificent style and with such apparent disregard for cost as these two volumes. One is immediately struck with the quality of the paper and type and the abundance and excellence of the photographic illustrations, a large number of which are photomicrographs, several being in colour. The

volumes constitute a fine example of the achievements of the modern printer.

The author, who is the son of Gardner F. Williams and has been in charge of operations at the De Beers group of mines at Kimberley for many years, is particularly well qualified for the task of writing an account of the diamond mines and of the industry generally, but he has not made a particularly happy choice of title for his volumes, which actually cover the whole subject of the diamond mines and diamond mining operations in South Africa, including the alluvial deposits, and are only concerned to a minor extent with the problem of the genesis of the diamond, even in South Africa.

On those aspects of the subject with which he feels most at home, such as the descriptions of the mines and of the methods employed in winning diamonds from them, the author is at his best ; but the greater part of the work is made up of quotations (some of which run to many pages) from the writings of practically all the authorities who have contributed to the literature of the South African diamond mines, as well as from others concerned with vulcanicity generally, interspersed with brief comments by the author. One would have liked to have had more of the author's own views, based on his unrivalled experience, with a summary of those of other authorities ; nevertheless it is useful to have such a collection of extracts dealing with the South African diamond deposits.

Volume I commences with an account of the modern methods of mining for diamonds and of diamond recovery, followed by a list of the localities where kimberlite occurrences have been discovered, with detailed descriptions of the more important mines. Next comes an account of the geology of South Africa and a discussion on the age of the kimberlite pipes. These preliminary chapters occupy 83 pages. The rest of the volume is devoted to a very detailed study of kimberlite, its composition, variations in texture and form, its origin and mode of injection, the origin of the pipes and fissures, and the inclusions both accidental and cognate to be found within them. These chapters contain a vast amount of valuable information and include many analyses hitherto unpublished.

The first fifty pages of Volume II continue the subject of cognate inclusions with a detailed petrographic study of these minerals. The next hundred pages or so are devoted to the diamond itself, the types found in different deposits, inclusions, crystallography and mode of growth,

and include a brief discussion on diamond genesis. The remaining hundred pages, which deal with the alluvial deposits of diamonds, have been reprinted *in toto* from the author's paper presented to the Third Empire Mining and Metallurgical Congress held in South Africa in 1930.

The arrangement of the subject-matter is very illogical, and better judgment could have been shown in the selection of matter for quotation, much of which could have been well spared; but the reader gets some compensation for this in the excellence of the numerous illustrations.

IGNEOUS ROCKS AND THE DEPTHS OF THE EARTH. Containing some Revised Chapters of "Igneous Rocks and Their Origin" (1914). By Reginald Aldworth Daly. (New York: McGraw-Hill Book Company, Inc.; London: McGraw-Hill Publishing Co., Ltd., 1933.) Price 30s.

This book is essentially a revised edition of the author's "Igneous Rocks and Their Origin," published in 1914, although only a comparatively small portion of the original text has been retained intact. New chapters and sixty new illustrations have been added, while seventy-five of the illustrations in the previous edition have been omitted.

Among the changes shown in the new edition may be mentioned: (1) doubt concerning the relation of the earth's contraction to mountain-building and to the ascent of igneous melts from depth; (2) emphasis on at least moderate horizontal displacement of large parts of the continental crust; (3) emphasis on magmatic stoping and the correlated abyssal pure melting of rocks, both on a scale considerably bigger than that imagined in 1914; (4) less emphasis upon liquid immiscibility in magmas; (5) more attention to the contrast in the magmatic conditions of early pre-Cambrian time as against Palæozoic and later times, in support of the author's contention that uniformitarianism is not an infallible guide in geology; (6) added emphasis on the fact that no one process can explain the diversity of the igneous rocks, especially the multitude of "alkaline" types.

For convenience, the book has been divided into three parts. The first seven chapters (166 pp.) deal with facts regarding igneous rocks that need explanation; the following seven chapters (222 pp.) are devoted to a general theory of igneous rocks; while the remaining eight chapters deal with the application of the general theory to the separate major groups or "clans" of eruptive rocks.

Among the salient facts requiring explanation, the

author enumerates the various types of igneous rocks, in addition to their distribution, mode of occurrence and relative quantities in time and space. He concludes that, qualitatively, the intermittent eruption of magmas has tended in a general way to follow uniformitarian lines, and that with respect to chemical diversity and modes of eruption, the visible pre-Cambrian, Palæozoic and Mesozoic bodies closely resemble those of Tertiary times. The rule, however, is subject to a number of exceptions, as for instance the apparent restriction of all the larger masses of anorthosite to late pre-Cambrian times.

The general theory elaborated to account for such facts as the above cannot be summarised adequately here, but it includes speculations on the constitution of the earth's outer shells, internal heat of the earth, abyssal injection, magmatic stoping, pure melting and assimilation of rocks, together with an elaborate exposition of the differentiation of magmas. Specific correlation of the theory with observed facts is attempted in Part 3, which gives a stimulating account of the gabbro, diorite, granodiorite, syenite, felspathoidal, ultramafic, and carbonate rock groups.

This book is undoubtedly an important contribution to the science of petrogenesis. Representing, as it does, the development of its author's views on this complex subject, it should prove of considerable interest and value to all petrologists.

Secondary Aluminium (Metallurgy, Technology, Raw Materials, Production, Economics, and Utilization). By Robert J. Anderson, D.Sc. Pp. xv + 563, 9¼ × 6¼. (Cleveland, Ohio: The Sherwood Press, Inc., 1931.) Price 42*s*.

The production of secondary aluminium has become one of the foremost branches of the world's aluminium industry, but hitherto its importance has not been generally recognised. During the 17-year period, from 1913 to 1929 inclusive, the total aluminium recovered annually in the United States increased from about 4,000 long tons, valued at nearly £½ million, to about 43,000 tons, valued at more than £4¾ million. It has further been estimated that the annual world turnover of secondary and scrap aluminium amounts to approximately one-half of the world output of primary metal.

Despite the above facts, the literature pertaining to secondary aluminium leaves much to be desired, and the need for a comprehensive treatise dealing with both secondary and scrap aluminium has long been apparent.

The present work is therefore designed to meet this want, and to serve as a general text- and reference-book on the subject.

The book is divided into twenty chapters, each with a selected bibliography. Chapter 1 deals with the secondary aluminium industry in general, interesting facts being given regarding the magnitude and organisation of the industry. This is followed by four chapters on scrap aluminium, with special emphasis on the varieties and sources, as well as observations relating to contamination, sorting, grading, and buying and selling of scrap. The next ten chapters are devoted principally to the metallurgy of scrap and secondary aluminium, and aluminium alloys, in addition to the recovery and disposal of by-products, while the ensuing chapters deal respectively with the costs of producing secondary aluminium, the quality and uses of the material, technical control in secondary practice, and finally the economic aspects of the industry.

The author has succeeded in bringing within a reasonable compass a well-balanced account of theory, plant operation and commercial practice that should prove of value not only to aluminium metallurgists, secondary remelters, scrap dealers, and manufacturers who produce scrap, but also to most consumers of aluminium and its alloys, especially foundrymen.

Chemistry and Technology of Cracking. By A. N. Sachanen, D.Sc., and M. D. Tilicheyev. Translated by A. A. Boehtlingk, D. F. Brown and K. T. Steik. Pp. 389, 9 × 6. (New York: The Chemical Catalog Company, Inc., 1932.) Price $8.00.

This book gives the results of experiments on cracking carried out over a period of four years at the Petroleum Research Institute of the Grozneft, Grosny.

Much more space is occupied by purely chemical and physico-chemical than by technological matters, as the greater part of the book is taken up with considerations relating to the fundamental features and chemistry of cracking; the composition of cracked compounds; the properties of cracked gasolines; cracked kerosenes and heavier oil distillates; and the residues, coke and gases obtained in cracking. The industrial technology of cracking is treated in sections dealing with the refining of cracked gasolines and with the principal cracking systems, a number of the most important processes being briefly described.

The final chapter deals with the chemistry and application of the hydrogenation of petroleum products, and

gives the results of experiments carried out by the authors on this subject.

The book, which is well produced and contains a large number of references to the literature of cracking, should be of considerable interest to those in any way connected with the scientific side of this industry.

BOOKS RECEIVED FOR NOTICE

A POLITICAL GEOGRAPHY OF THE BRITISH EMPIRE. By C. B. Fawcett, B.Litt., D.Sc. Pp. xiii + 409, 8¾ × 5¾. (London: University of London Press, Ltd., 1933.) Price 18*s*. net.

MODERN FRUIT GROWING. By W. P. Seabrook. Pp. xi + 292, 8½ × 5½. Fourth Edition, Enlarged and Rewritten. (London: Ernest Benn, Limited, 1933.) Price 7*s*. 6*d*.

A TEXTBOOK OF GEOLOGY. PART II—HISTORICAL GEOLOGY. By Charles Schuchert and Carl O. Dunbar. Pp. vii + 551, 9 × 6. Third Edition, Largely Rewritten. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1933.) Price 25*s*.

MINERAL DEPOSITS OF THE CANADIAN SHIELD. By E. L. Bruce, B.Sc., Ph.D. Pp. xxiv + 428, 9 × 6. (Toronto: The Macmillan Company of Canada, Limited.) Price 25*s*. net.

ORES AND INDUSTRY IN THE FAR EAST. The Influence of Key Mineral Resources on the Development of Oriental Civilisation. By H. Foster Bain, with a chapter on Petroleum by W. B. Heroy. Revised and Enlarged Edition. Pp. xvi + 288, 9 × 6. (New York: Council on Foreign Relations, Inc., 1933.) Price $3.00.

HISTORY OF THE THEORY OF ORE DEPOSITS. WITH A CHAPTER ON THE RISE OF PETROLOGY. By Thomas Crook, A.R.C.S., F.G.S., M.I.M.M. Pp. 163, 8½ × 5½. (London: Thomas Murby & Co., 1933.) Price 10*s*. 6*d*. net.

THE ECONOMICS OF MINING (NON-FERROUS METALS). VALUATION — ORGANIZATION — MANAGEMENT. By Theodore Jesse Hoover. Pp. viii + 547, 9 × 6. (California: Stanford University Press; London: Mr. Humphrey Milford, Oxford University Press, 1933.) Price 29*s*. 6*d*.

THE PORPHYRY COPPERS. By A. B. Parsons. Pp. xv + 581, 9 × 6. (New York: The American Institute of Mining and Mechanical Engineers, 1933.) Price $5.00.

PRECIPITATED CHALK. History, Manufacture and Standardisation. By A. P. Wilson, M.A. Pp. 51, 9 × 6. (Birmingham: John & E. Sturge, Ltd., 1933.) Price 2*s.* 6*d.*

ON THE MINERALOGY OF SEDIMENTARY ROCKS. A SERIES OF ESSAYS AND A BIBLIOGRAPHY. By P. G. H. Boswell, A.R.C.S., D.I.C., F.R.S., Sec.G.S. Pp. ix + 393, 8½ × 5½. (London: Thomas Murby & Co., 1933.) Price 21*s.* net.

ELEMENTS OF OPTICAL MINERALOGY. AN INTRODUCTION TO MICROSCOPIC PETROGRAPHY. By Alexander N. Winchell. Third edition. Part II. Descriptions of Minerals. Pp. xviii + 459, 9 × 6. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd.) Price 37*s.* 6*d.*

SPECTROSCOPY IN SCIENCE AND INDUSTRY. By S. Judd Lewis, D.Sc.(London), D.Sc.(Tübingen), F.I.C., Ph.C. Pp. vi + 94, 7½ × 5. (London: Blackie & Son, Ltd., 1933.) Price 3*s.* 6*d.*

REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

Selected from the Reports made to the Dominion, Colonial and Indian Governments

DERRIS ROOTS FROM NEW GUINEA

Derris or tuba root has during recent years become established as a valuable insecticidal material. Commercial derris comes from Malaya, Sarawak, British North Borneo and the Dutch East Indies, and is derived from several related species, of which *Derris elliptica* is the most important. This is a climbing shrub, which flourishes best in low-lying districts in the tropics and prefers a very moist soil. At first the roots were obtained from wild plants or were grown in their gardens by the natives, who use the material as a fish poison. In the last few years, however, derris has been cultivated in the East as a secondary crop in plantations of rubber, oil palms and coconut palms. It is stated that in 1931 the area planted under derris in Malaya was over 5,000 acres.

Derris root is not subjected to any preparation after collection other than drying and removal of dirt. In Malaya, immediately after harvesting, the fresh roots are placed in open sheds, where they are spread out and allowed to dry for about ten days. On a few estates, the roots are passed through hot-air driers of the Chula type used for drying copra. It is essential that the roots be thoroughly dry and quite clean before packing. For export it is understood that the dried root is packed in bales of about 225 lb. and compressed to 12 cu. ft. to save freightage. The roots are sometimes finely chopped, the product being then packed in Venesta or other light wooden chests. Experiments are now in progress on the shipment of derris root in the powdered form.

The value of any particular consignment of derris root depends on its content of the toxic principle, rotenone, and samples have been analysed which varied in rotenone content from *nil* to 7 per cent. Considerable work has been and is still being done regarding the toxic value of the different species of derris, the optimum age for the collection of the roots and the methods of preparation. At present there is apparently no regular commercial standardisation of the product on the basis of rotenone content, but it is likely that such will become the practice in the future. The question of the estimation of rotenone in derris root is discussed in "The Valuation of Tuba Root," by C. D. V. Georgi and Gunn Lay Teik, published as *Bulletin No.* 12, 1933, *Scientific Series, Department of Agriculture, Straits Settlements and Federated Malay Straits.*

The principal use of derris root is in the manufacture of insecticides employed in the horticultural and live-stock industries. The preparations made from it include powders and various forms of extract. Rotenone, the chief active principle of derris, has been shown to be very effective in dealing with a wide variety of insects, yet at the same time is generally considered to be non-toxic to human beings and warm-blooded animals.

The following particulars of exports from the chief producing countries for which figures are available will give some indication of the trade in derris root :

Exports of Derris Root (in tons)

	1930.	1931.	1932.	January–August 1933.
Malaya . . .	55½	74¼	167	350¼
British North Borneo .	34½	25	(*a*)	(*a*)
Sarawak . . .	735	108	37¼	(*a*)
Sumatra . . .	3	8¼	2	(*a*)
Dutch Borneo . .	3	4	1¼	(*a*)

(*a*) *Not available.*

In 1932, of the root exported from Malaya approximately 40 per cent. was shipped to the United Kingdom, 24 per cent. to the United States and 20 per cent. to Japan.

The price of derris has fallen considerably during recent years. The spot price of derris root in London according to the *Chemist and Druggist* is 8½*d.* per lb. (November 1933), as compared with 10*d.* per lb. earlier in the year.

It is of interest to note that there have recently appeared in London samples of a similar root from South America known as Cube (pronounced " coo bay ") and sometimes also referred to as Barbasco, the latter word being a general name given to fish poisons in Spanish America. Cube root is the product of the plant *Lonchocarpus nicou*, which grows wild principally in the Upper Amazon basin in Peru and Brazil, and according to one authority it may contain as much as 11 per cent. of rotenone, a figure considerably higher than the maximum that appears to have been recorded for derris. Should supplies of cube root become available in commercial quantities it seems likely that it will prove a serious competitor of derris.

In February 1933, two samples of derris were forwarded to the Imperial Institute by the Director of Agriculture, New Guinea, with a view to ascertaining the percentage of rotenone in the samples in comparison with that in Malayan derris root. The species from which the material was derived was not stated.

The samples were as follows :

1. *Fine Roots.*—These were greyish-brown roots varying from $\frac{1}{8}$ to $\frac{1}{2}$ in. (mostly about $\frac{1}{2}$ in.) in diameter, and from 3 to 18 in. in length. The roots possessed a somewhat fibrous fracture.

2. *Coarse Roots.*—This sample consisted of greyish-brown roots varying from $\frac{1}{2}$ in. to 2 in. in diameter, and mostly about 12 in. long with occasional branched pieces. The roots possessed a fibrous fracture.

The samples were examined by a method for the estimation of rotenone which was recently published by the United States Department of Agriculture and depends on the extraction of the root with carbon tetrachloride. This process is stated to permit of a ready separation of the rotenone in a purer state than with the older method in which ether is used for extraction. The estimations gave the following results, which are shown in comparison with those obtained for a commercial sample of Malayan *Derris elliptica* roots :

—	Present Samples from New Guinea.		Commercial Sample of Malayan Roots.
	Fine roots.	Coarse roots.	
	Per cent.	*Per cent.*	*Per cent.*
Moisture	7·8	7·4	10·2
Total carbon tetrachloride extract[1]	7·8	4·8	10·4
Rotenone[1]	3·2	2·1	2·2

[1] *Expressed on the moisture-free material.*

The results show that the rotenone content of each of the present samples from New Guinea compared satisfactorily with that of the commercial sample of Malayan *Derris elliptica* roots used for comparison.

In this connection it is of interest to mention that the derris root of commerce is derived from more than one species, and that the rotenone content of different samples has been found to vary considerably, both with the species and also with the age of the plant from which the roots are obtained. Thus, H. A. Jones (*Journal of the Washington Academy of Sciences*, **23**, 1, January 15, 1933, pp. 36–46) has recorded the results of the examination of a number of commercial samples of derris root by the carbon tetrachloride method which ranged from *nil* to 6·9 per cent.

The following fairly concordant results were also obtained by Jones (*loc. cit.*) by the carbon tetrachloride method for three authentic samples of *Derris elliptica* roots from Malaya, the results being expressed in each case on the air-dried material :

Sample.		Percentage of Rotenone.
No. 1		1·4
No. 2		1·8
No. 3	Fine root	2·3
	Coarse root	2·0
	Average root	2·1

From these results and that now obtained at the Imperial Institute with a commercial sample of Malayan roots it would appear that the present materials from New Guinea may be regarded as containing satisfactory amounts of rotenone as compared with those obtainable from the roots of the *Derris elliptica* of Malaya.

KINO OF *PTEROCARPUS ANGOLENSIS* FROM SOUTHERN RHODESIA

Two samples of the kino of *Pterocarpus angolensis* were forwarded to the Imperial Institute by the Department of Agriculture and Lands, Southern Rhodesia, in June 1933, in order to ascertain whether the material would be of commercial interest. *Pterocarpus angolensis* is a tree 15 to 20 ft. in height, belonging to the natural order *Leguminosæ*, and occurs in a belt across Africa from Angola in the west to Portuguese East Africa, extending southwards as far as the Eastern Bushveld in the Transvaal. In Southern Rhodesia the tree is known as " mukwa."

The samples, which were stated to have been obtained in the Mtao and Gwaai Reserves by wounding the bark, were as follows :

No. 1. *Mtao Reserve.*—This sample resembled Malabar kino (*Pterocarpus Marsupium*) in appearance, and consisted of ruby-red, brittle, irregular, angular fragments, up to about ½ in. in maximum thickness. The fragments generally exhibited a glassy surface and possessed a vitreous fracture. The sample on the whole was fairly " bright " in appearance and was moderately free from " dust " and pieces of bark.

No. 2. *Gwaai Reserve.*—This sample consisted of brittle, irregular fragments up to about ¾ in. in maximum thickness. The colour of the fragments was generally dull ruby-red ; the surface was only moderately bright. The sample as a whole possessed a rather dull appearance, and it contained some " dust " and pieces of bark.

The samples were analysed with the following results, which are shown in comparison with those recorded by Hooper (*Yearbook of Pharmacy*, 1900), for Malabar kino :

	Present Samples.		Malabar Kino.
	No. 1.	No. 2.	
	Per cent.	*Per cent.*	*Per cent.*
Moisture	15·4	15·1	12·2 to 15·7
Insoluble matter	4·3	4·9	0·4 to 5·1
Extractive matter (non-tannin)	7·6	10·5	1·1 to 11·5
[1] Tannin	72·7	69·5	70·0 to 82·4
Ash	1·4	0·9	1·0 to 2·3

[1] *The analysis was made by the Official International Method of Tanning Analysis, using Hide Powder Batch No. C. 4. The Reiss method of filtration and Procter method of extraction were employed.*

Malabar kino is not included in the last edition (1932) of the British Pharmacopœia, but it appeared in the earlier edition (1914) and the following table shows the characters of the present samples in comparison with those there specified for Malabar kino :

Requirements of the British Pharmacopœia (1914) for Malabar Kino.	Present Samples from Rhodesia.	
	No. 1	No. 2.
Small, angular, glistening, opaque, reddish-black, brittle fragments Transparent in thin laminæ, very astringent taste	In general agreement	Inferior dull appearance
Almost entirely soluble in 90 per cent alcohol.	Slowly soluble with perceptible insoluble residue	Slowly soluble with perceptible insoluble residue
Slowly and incompletely soluble in cold water, not less than 75 per cent soluble in boiling water	In agreement	In agreement
Almost entirely soluble in ether	Sparingly soluble	Sparingly soluble.
Aqueous solution yields voluminous reddish precipitate with dilute mineral acids	Reddish yellow precipitate	Reddish-yellow precipitate
Dilute aqueous solution gives greenish black precipitate with ferric chloride reagent	In agreement	In agreement.
Ash not more than 2.5 per cent.	In agreement	In agreement.

The astringency of Sample No. 1, as indicated by its tannin content, was comparable with that of Malabar kino, and its appearance, characters and reactions are seen to show a general, though not entire, concordance with the requirements of the 1914 edition of the British Pharmacopœia for that material. The astringency of Sample No. 2, as indicated by its tannin content, was slightly below the range for Malabar kino, and its inferior appearance would render the material less acceptable than Sample No. 1.

In view of the fact that both samples are from the same botanical source in Southern Rhodesia, it seems probable that the inferior appearance of Sample No. 2 may be due to lack of care in preparation. In the case of *Pterocarpus Marsupium* it is necessary to boil the exuded juice before evaporation, to destroy the oxidase naturally present and thus prevent subsequent oxidation of the kino-tannic acid, a change which gradually imparts a dull appearance to the product. It is probable that this pre-

caution would be justified in the case of the present material.

Portions of the samples were submitted to wholesale druggists in London, who furnished the following report :

" We have been interested to examine the two samples of kino from Southern Rhodesia.

" It seems to us that the samples compare favourably in appearance with the Malabar kino, although as you will have observed the colour is somewhat lighter, being a reddish-brown instead of a reddish-black.

" The present value of Malabar kino ranges from 9*d.* to 1*s.* per lb. according to quality, and we can think of no reason why kino from Southern Rhodesia could not command the same price.

" We believe it is true to say that the demand for kino is now much smaller than in the past. It is certainly true that the demand for kino for medicinal purposes is very much less than it used to be."

STONEWARE CLAYS FROM NIGERIA

A LARGE number of clays from Nigeria have been examined at the Imperial Institute during the last 25 years, in most instances from the point of view of their suitability for the manufacture of bricks, tiles, and, in some cases, pottery.

Three samples of clay were forwarded recently by the Public Works Department, Nigeria, and it was requested that their suitability for the manufacture of stoneware, sewer pipes and sanitary ware might be determined. A number of years have elapsed since any example of this aspect of the clay-testing work of the Imperial Institute was published in this BULLETIN, and an account of the work done and the results obtained in this investigation may be of interest.

When divergences from modern commercial practice are noticed, it must be remembered that the conditions under which the ware would have to be made in Nigeria have been taken into consideration, and simple processes are suggested whenever possible.

Description of Samples

Clay No. 1, from Iva Valley, Enugu.—This sample consisted mainly of light grey iron-stained clay, associated with a quantity of finely divided quartz.

Clay No. 2, from Ozobolo.—This was a light greyish-brown friable clay in the form of nodules and irregular lumps, associated with finely divided quartz. It was considerably iron-stained, and a small quantity of partly decayed vegetable matter was present.

Clay No. 3, from Newi.—This sample consisted of light reddish-brown very friable lumps of clay, with a small quantity of finer material. It contained a quantity of quartz, in grains up to about $\frac{1}{8}$ in. in diameter, in addition to larger fragments of hard ferruginous matter.

Results of Examination

A quantity of each sample was washed, with the results appended below:

TABLE I

—	Clay No. 1.	Clay No. 2.	Clay No. 3.
Clay (*per cent.*)	69·9	53·3	45·0
Residue „	30·1	46·7	55·0
Description of residue	Mainly finely divided greyish iron-stained quartz	Mainly finely divided quartz, considerably iron-stained, with some grains of ferruginous matter	Chiefly brown iron-stained quartz, containing particles up to $\frac{1}{8}$ in. diameter, with a quantity of ferruginous matter.

Chemical analyses of the crude clays and also of the washed products obtained from them gave the following percentage results:

TABLE II

—		Clay No. 1. Raw Clay.	Clay No. 1. Washed Clay.	Clay No. 2. Raw Clay.	Clay No. 2. Washed Clay.	Clay No. 3. Raw Clay.	Clay No. 3. Washed Clay.
Silica	SiO_2	70·07	68·27	66·51	52·56	66·68	44·78
Alumina	Al_2O_3	14·70	17·62	14·96	23·26	16·23	29·30
Ferric oxide	Fe_2O_3	4·36	2·44	4·92	6·48	5·66	6·92
Titanium dioxide	TiO_2	1·97	2·24	1·20	1·66	1·76	2·49
Lime	CaO	0·39	0·16	0·42	0·40	0·07	0·11
Magnesia	MgO	0·39	0·40	0·56	0·71	0·33	0·35
Potash	K_2O	0·78	0·93	1·74	1·72	0·24	0·16
Soda	Na_2O	0·05	*nil*	0·58	0·46	0·02	0·04
Loss on ignition		7·54	7·89	8·99	12·36	9·43	15·69

These results show that the percentages of fluxes are too low to permit of the utilisation of any of these clays as natural stoneware clays, and that appropriate amounts of finely ground fluxes would have to be added.

Results of Technical Trials

Clay No. 1, from Iva Valley, Enugu

Preliminary Trials.—Preliminary tests were made with the crude and washed clays by moulding small test bars of the materials, which were air-dried at ordinary temperature and fired at 1,280° C. The crude clay worked fairly well but had a tendency to be somewhat deficient in plasticity, while the washed clay was plastic and inclined to be sticky.

An inspection of the fired products, which were of a deep cream colour, showed that neither the crude nor the washed clay gave any sign of vitrification at the temperature of firing. The test pieces made from the crude clay were somewhat marred by iron spots, but no tendency to crack was observed.

Products made from the washed clay, however, were very dense, but there were indications that any large pieces formed from this material would probably show surface cracks if fired at the temperature used for this trial.

In view of the facts that little reduction in the silica content of the clay was effected by washing, that the quartz was present in a finely divided form, and that the results of the preliminary firing of the crude clay appeared promising, it was decided that so far as the making of sanitary ware and sewer pipes was concerned, no useful purpose would be served by continuing the experiments with the washed clay, the preparation of which would, in any case, add to the cost of manufacture of the products. The presence of iron spots in the fired clay would restrict the use of the crude clay to the fabrication of common stoneware (e.g. sewer pipes, etc.) for local use, and the majority of the experiments with this clay have been carried out with this object in view.

Vitrification Range of the Crude Clay (*No.* 1).—Small test bars of the crude clay were used for these determinations, the results of which are tabulated below :

TABLE III

VITRIFICATION RANGE OF IVA VALLEY CLAY

Maximum Firing Temperature.	Porosity[1] *Per cent.*	Colour.	Warpage.
1,000° C.	29·4	Light salmon pink	*nil*
1,050° C.	29·1	" " "	"
1,100° C	28·7	" " "	"
1,150° C.	28·5	Pinkish white	"
1,200° C.	27·7	" "	"
1,250° C.	25·7	Cream	"
1,300° C	24 5	Dark greyish cream	"

[1] *Volume of pores expressed as percentage volume of whole piece*

The above results indicated that the neat clay would not produce impermeable stoneware when fired at the temperature usually employed for this type of ware, i.e. about 1,300° C. This, as shown in the chemical analysis in Table II, is explained by the deficiency of fluxes, which, in a stoneware clay, should normally amount to about 5 per cent.

Preliminary Trials of Crude Clay No. 1 *in Admixture with Felspar.*—On account of the results described above, attempts were made to obtain a superior and less porous product by the addition of felspar to the crude clay in such a proportion as to increase the percentage of fluxes in the fired body to the required amount. The composition of the felspar used in these experiments was as follows :

TABLE IV

		Per cent.
Silica	SiO_2	64·2
Alumina	Al_2O_3	19·6
Ferric oxide . . .	Fe_2O_3	0·3
Lime	CaO	1·4
Magnesia	MgO	0·5
Potash	K_2O	9·3
Soda	Na_2O	3·5
Loss on ignition	—	1·4

A mixture of 100 parts of the crude clay No. 1 and 31 parts of the above felspar would yield a fired body having approximately the following composition :

TABLE V

		Per cent.	
Silica	SiO_2	73·15	
Alumina	Al_2O_3	16·90	
Ferric oxide	Fe_2O_3	3·62	
Titanium dioxide	TiO_2	1·60	
Lime	CaO	0·67	5·03
Magnesia	MgO	0·45	
Potash	K_2O	2·98	
Soda	Na_2O	0·93	

Such a mixture was made, and its vitrification range determined in a similar manner to that used for the neat clay. These results are shown below in Table VI.

In localities where the cost of ground felspar is a matter of importance, finely ground calcareous materials are sometimes used in its place, but with such fluxes losses may be incurred on account of the shorter vitrification range of the mixture employed, and the consequent liability of the ware to deformation.

TABLE VI

VITRIFICATION RANGE OF IVA VALLEY CLAY AND FELSPAR MIXTURE

Maximum Firing Temperature.	Porosity. Per cent.	Colour.	Warpage.
1,000° C	30·5	Light salmon pink	*nil*
1,050° C.	29·0	Light creamy pink	,,
1,100° C	24·5	Light cream	,,
1,150° C.	15·5	,, ,,	,,
1,200° C.	6·8	Greyish cream	,,
1,250° C	4·0	Light grey	Slight tendency
1,300° C.	2·5	,, ,,	,,

The above results indicated that a fair quality stoneware might be obtained from the mixture using a firing temperature of 1,200–1,250° C. It was not considered advisable to carry out experiments at temperatures exceeding 1,250° C. on account of the limitations of the temperatures attainable in the kilns which would presumably be employed in Nigeria, and the tendency of the ware to soften and warp at higher temperatures.

Further Tests of Clay-Felspar Mixtures, with Special Reference to Sewer-pipe Production.—A quantity of the raw clay was ground to pass a sieve containing 30 meshes per linear inch, and mixed with the correct proportion of finely ground felspar. The clay (ground to 30 mesh)

used in this mixture was considerably coarser than that usually employed in commercial practice, but, as was the case in deciding the firing temperature, allowance was made for the less refined methods likely to be employed in Nigeria.

The mixture of clay and felspar, after being tempered with water, was allowed to age for 24 hours at room temperature, in order to develop its maximum plasticity. After this period it was passed twice through a horizontal pug mill, to ensure thorough mixing, and then transferred to an auger machine for the extrusion of pipes.

It was found that when the correct working consistency of the clay mixture had been attained, the mass extruded well, with no tendency towards cracking or tearing of the pipes. These were cut off, as extruded, by means of a stretched wire and stacked to dry at room temperature, no attempt being made to control the humidity of the atmosphere. No cracking or warping of the pipes took place under this treatment and they were then fired at 1,200° C. The results of tests carried out on these trial pipes are recorded in Table VII, together with the results of similar tests carried out on ware made from the neat clay. As an indication of the strength of the fired material, the transverse breaking stress and crushing strength of pressed ware made from the same mixture as these pipes is given in Tables X and XI.

TABLE VII

TESTS ON A SEWER-PIPE MIXTURE MADE FROM IVA VALLEY CLAY

		100 parts Clay + 31 parts Felspar.	Neat Clay.
Water of formation	*per cent.*	17·4	15·7
Maximum firing temperature	*degrees C*	1,200	1,250
Duration of firing at maximum temperature	*hours*	6	6
Drying shrinkage (linear)	*per cent.*	5·5	5·5
Firing ,, ,,	,, ,,	16·5	2·4
Total ,, ,,	,, ,,	22·0	7·9
Porosity	,, ,,	6·4 [1]	21·9 [1]
Water absorption	,, ,,	2·4	11·3
Colour of fired ware		Light grey	Cream, iron-spotted
Ring		Good	Fair

[1] *Porosity of English-made sewer pipe is about 5 to 7 per cent.*

These results showed that though the total shrinkage of the clay-felspar mixture was somewhat high, the porosity was comparable with that of English sewer pipes.

Salt Glazing of Sewer Pipes.—A further series of pipes was fired in an experimental down-draught kiln and salt glazed at 1,200° C. The glazed pipes, whilst being satisfactory from the point of view of impermeability, were darker in colour than those usually met with in commerce, probably on account of the reaction of the salt with the ferruginous compounds present in the clay.

The texture of the pipes was marred by small pits, approximately $\frac{1}{32}$ in. diameter, probably caused in the same way, but on examination it was found that all these pits were sealed and impervious, and would not affect the durability and efficiency of the ware in use.

Sewer-pipe Mixtures, incorporating Grog in addition to Felspar and Clay.—As may be seen from Table VII, the pipes made from the mixture of this clay and felspar had an extremely high shrinkage, and were very dense. Such pipes would in all probability prove to be rather brittle for commercial use and would also be difficult to cut.

An attempt to improve the ware in this respect was made by adding grog to the mixture of clay and felspar. The grog was prepared by firing a quantity of the crude clay at a temperature of 1,200° C. and then grinding and grading the fired product. The material used for these experiments was that which passed a 30-mesh sieve (aperture 0·0228 in.), and was retained on a 50-mesh sieve (aperture 0·0115 in.). It was considered that the crude clay contained sufficient finely divided inert material, and that the introduction of grog, more finely ground, would serve no useful purpose.

A mixture of 90 per cent. of the clay-felspar mixture and 10 per cent. of graded grog was made, tempered with water, and allowed to age for 24 hours. After this period, the moist mass was passed twice through a horizontal pug mill, and then transferred to the extrusion machine described above. The mixture extruded well and the walls of the pipes were of a good texture. The pipes thus made were stacked to dry under conditions similar

to those employed for the clay-felspar mixture previously described, and were afterwards fired at 1,200° C. with the results shown in Table VIII.

TABLE VIII

TESTS ON A SEWER-PIPE MIXTURE OF IVA VALLEY CLAY, FELSPAR AND GROG

Water of formation	*per cent.*	16·0
Maximum firing temperature	*degrees C.*	1,200
Duration of firing at maximum temperature	*hours*	6
Drying shrinkage (linear)	*per cent.*	5·3
Firing " "	" "	6·2
Total " "	" "	11·5
Porosity	" "	5·9
Water absorption	" "	2·6
Colour of fired ware		Light grey
Ring		Good

It will be seen that the total shrinkage was in this case much less than with the clay-felspar mixture, though the porosity was of the same order as before.

A further quantity of experimental pipes made from the clay-felspar-grog mixture was salt-glazed at a temperature of 1,200° C. The texture and colour of the glazed pipes were similar to those obtained with the felspar and clay mixture, and the remarks made under that heading are equally applicable.

Paving Tiles and Pottery.—A quantity of the crude clay, previously ground to pass a sieve having 30 meshes per linear inch, was mixed with the correct amount of finely ground felspar, tempered with water and allowed to age for 24 hours. At the end of this period the material was divided into two parts, one half being reserved for making pressed tiles, and the other for the production of pottery on the jigger and jolley machine. This latter portion was mixed with a further quantity of water and the ageing period increased to 48 hours.

(1) *Paving Tiles.*—When mixed with water to the consistency of that generally employed for the stiff plastic process of brickmaking, the mixture of clay and felspar pressed well in metal moulds and dies, with a normal amount of lubrication, and the freshly made pieces had a good surface and sharp edges.

A few hand-moulded experimental pieces were made in plaster of Paris moulds with fairly good results, the unfired ware showing no tendency to warp or crack provided that reasonable care in drying was observed. The results of tests carried out on specimens made by pressing in metal moulds are shown in Tables IX and X. Similar tests were also carried out on the neat clay, ground to pass a sieve having 30 meshes per linear inch, and the results are also included in these tables for comparison.

TABLE IX

TESTS ON A PAVING-TILE MIXTURE MADE FROM IVA VALLEY CLAY

		100 parts Clay + 31 parts Felspar.	Neat Clay.
Water of formation	*per cent*	12·7	11·2
Maximum firing temperature	*degrees C.*	1,200	1,250
Duration of firing at maximum temperature	*hours*	6	6
Drying shrinkage (linear)	*per cent*	1·5	2·3
Firing ,, ,,	,, ,,	6·8	5·0
Total ,, ,,	,, ,,	8·3	7·3
Porosity (mean of six tests)	,, ,,	6·4	25·7
Water absorption (mean of six tests)	,, ,,	2·4	12·9
Colour of fired ware		Light grey	Cream, iron-spotted
Ring		Good	Fair

TABLE X

MODULUS OF RUPTURE

Span = 5 in. Rate of loading 5 lb. per minute

Specimen.	100 parts Clay + 31 parts Felspar. Raw.	Fired.	Neat Clay. Raw.	Fired.
	lb. per sq. in.	*lb. per sq. in.*	*lb. per sq. in.*	*lb. per sq. in.*
1	58	2,687	192	802
2	69	2,683	193	911
3	65	2,271	213	823
4	64	2,933	216	900
5	63	2,971	220	963
6	72	2,706	202	890
Mean	65	2,709	206	897

A further series of test pieces made from the clay and felspar mixture, fired at 1,200° C., were tested for compressive strength, and the results obtained are shown in Table XI.

TABLE XI

COMPRESSION TESTS

Area of specimen = approx. 8 sq. in. Rate of loading = 500 lb. per sq. in. per minute.

Specimen.	Cracking Strength.	Crushing Strength.
	lb. per sq. in.	*lb. per sq. in.*
1	5,600	13,670
2	4,674	12,730
3	Indefinite	15,400
4	6,368	12,300
Mean	5,547	13,525

The total shrinkage was in this case reduced, on account of the smaller amount of water used in making the ware and the method of formation. The results of the transverse and compression tests showed that the material possessed considerable strength.

(2) *Pottery.*—The mixture of crude clay and felspar, after an ageing period of 48 hours, was thoroughly pugged by hand, and portions moulded on the jigger and jolley machine, but the small vessels thus produced were of a somewhat poor texture on account of the fairly large proportion of coarse particles contained in the sample. This defect was considerably reduced by grinding the clay to pass a sieve containing 60 meshes per linear inch, but the general moulding properties of the mixture were still inferior to those of a good stoneware clay. No tendency to warp or crack during drying was observed and the vessels after drying at room temperature were fired at 1,200° C. The results of tests carried out on test pieces thus produced are shown in Table XII, together with those obtained from test pieces made from the crude clay under similar conditions.

TABLE XII

TESTS ON POTTERY FROM IVA VALLEY CLAY

		100 parts Clay + 31 parts Felspar.	Neat Clay.
Water of formation	*per cent.*	17·8	16·7
Maximum firing temperature	*degrees C*	1,200	1,250
Duration of firing at maximum temperature	*hours*	6	6
Drying shrinkage (linear)	*per cent.*	5·5	6·7
Firing " "	" "	16·5	3·5
Total " "	" "	22·0	10·2
Porosity (mean of six tests)	" "	5·4	18·1
Water absorption (mean of six tests)	" "	2·4	9·1
Colour		Light grey	Cream, iron-spotted
Ring		Good	Fair

The total shrinkage was again high, on account of the method of moulding the ware and the increased amount of water used. There was little alteration in the porosity.

Production of Sanitary Ware.—The term "sanitary ware" is applied to several different varieties of material, some having more permeable bodies than others. Such ware is usually covered with an opaque glaze, but is sometimes salt-glazed. The experiments carried out at the Imperial Institute were directed towards the production of an impermeable clay-felspar body, of the same composition as that used for the production of sewer pipes, but covered with an opaque white glaze.

For the purpose of these experiments a felspathic stoneware matt glaze having the formula

$$\left.\begin{matrix} K_2O & 0{\cdot}3 \\ CaO & 0{\cdot}7 \end{matrix}\right\} Al_2O_3 \quad 0{\cdot}7 \qquad SiO_2 \quad 2{\cdot}0$$

was made from the following ingredients :

Clay No. 1	20 parts (by weight)
Felspar	54 ,, ,, ,,
Chalk	2 ,, ,, ,,
Flint	4 ,, ,, ,,

These constituents were ground with water in a ball mill for two hours and then passed through a sieve having 100 meshes per linear inch.

This glaze was applied to biscuit ware made of the clay-felspar mixture already described, but in this case fired at about 1,000–1,100° C., and was then matured at 1,250° C. It produced a greyish-coloured matt surface which successfully hid the iron spots disfiguring the body.

Another glaze of similar composition, but substituting a suitable proportion of English kaolin for the Nigerian clay, was also made. This glaze, which matured at approximately the same temperature as the Nigerian clay glaze, was of a much better colour, yielding a dense, white product.

Both glazes adhered well to the clay-felspar body, and exhibited no tendency towards either crazing or shivering.

Production of Fine Stoneware.—The production of high-class stoneware of good colour from the crude clay is not feasible on account of the high iron content of the clay, but ware of a poor appearance can be obtained

after fine grinding of the clay and the addition of felspar, the texture of the fired product being marred by iron spots.

Preliminary experiments with the washed clay indicated that a product suitable for local use could be made from a mixture of 100 parts by weight of the washed clay and 32 parts of felspar (for analysis of the felspar used see p. 478).

The theoretical composition of the fired body obtained from such a mixture is given below in Table XIII, and the results of such tests as it was possible to carry out with the quantity of material available, are set out in Table XIV.

TABLE XIII

COMPOSITION OF STONEWARE FROM IVA VALLEY CLAY AND FELSPAR

		Per cent.	
Silica	SiO_2	71·81	
Alumina	Al_2O_3	19·32	
Ferric oxide	Fe_2O_3	2·05	
Titanium dioxide	TiO_2	1·81	
Lime	CaO	0·49	5·01
Magnesia	MgO	0·45	
Potash	K_2O	3·16	
Soda	Na_2O	0·91	

TABLE XIV

TESTS ON STONEWARE MIXTURE MADE FROM IVA VALLEY CLAY AND FELSPAR

Water of formation	*per cent.*	22·7
Maximum firing temperature	*degrees C.*	1,250
Duration of firing at maximum temperature	*hours*	6
Drying shrinkage (linear)	*per cent.*	4·5
Firing ,, ,,	,, ,,	8·1
Total ,, ,,	,, ,,	12·6
Porosity	,, ,,	3·1
Water absorption	,, ,,	1·4
Colour		Light grey
Ring		Very good

The total shrinkage was in this case not excessive, and the porosity was lower than in any of the felspar mixtures made with the crude clay.

Wall Tiles.—This class of ware is usually manufactured from an earthenware body, fired at a much lower temperature than stoneware. The crude clay is unsuitable for this purpose on account of the very high porosity and general weakness of the biscuit produced at the usual temperature of earthenware firing. Increasing the firing temperature to that employed in the manufacture of stone-

ware yields a stronger material, but the surface of the ware is considerably marred by the presence of iron spots.

Attempts were therefore made to use the washed clay for the fabrication of tiles, and small test bars made by hand from this material in plaster moulds were fired at 1,080° C. with the results shown in Table XV.

TABLE XV

TESTS ON WALL TILES FROM IVA VALLEY CLAY (WASHED)

Water of formation	*per cent*	25·2
Maximum firing temperature	*degrees C.*	1,080
Duration of firing at maximum temperature	*hours*	6
Drying shrinkage (linear)	*per cent.*	7·5
Firing ,, ,,	,, ,,	2·0
Total ,, ,,	,, ,,	9·5
Porosity	,, ,,	26·9
Water absorption	,, ,,	14·2
Colour		Dark cream
Ring		Fairly good

These results show that the properties of the biscuit approximated to those of inferior earthenware. The porosity was high.

The fired material was somewhat weak, and attempts were made to obtain stronger ware by the addition of finely ground ball clay to the washed clay.

This latter mixture, although somewhat more sticky that the neat washed clay, could be moulded fairly well in plaster moulds, and when fired at 1,080° C. yielded a body having the physical properties shown in Table XVI.

The usual earthenware mixture from which glazed wall tiles are produced, consisting of clay, flint, felspar and ball clay, was not made, as it was considered that for tiles intended for local use, such a mixture would be an unnecessary refinement, and would unduly complicate the method of manufacture.

TABLE XVI

TESTS ON WALL TILES FROM IVA VALLEY CLAY AND BALL CLAY

Water of formation	*per cent.*	26·5
Maximum firing temperature	*degrees C.*	1,080
Duration of firing at maximum temperature	*hours*	6
Drying shrinkage (linear)	*per cent.*	8·5
Firing ,, ,,	,, ,,	4·0
Total ,, ,,	,, ,,	12·5
Porosity	,, ,,	23·7
Water absorption	,, ,,	12·1
Colour		Dark cream
Ring		Good

The increased shrinkage and decrease in porosity indicated that the addition of ball clay had improved the quality of the product.

Specimens of the biscuit ware prepared from the washed clay with and without the addition of ball clay were glazed with a commercial white opaque glaze, which was fairly successful in hiding the colour of the body, and adhered without serious crazing.

No attempts were made to prepare an opaque earthenware glaze from the clay on account of the poor colour that would be obtained, and if it were desired to make tiles and cover them with a glaze similar to that used in these experiments, it would probably be more satisfactory to purchase one of the many ready-prepared types commercially available rather than to manufacture the glaze locally.

It will be observed that in certain of the above tables, e.g. Nos. VII, IX and XII, the results of tests carried out on ware made from mixtures of the same composition are given. The varying results recorded are explained by differences in the conditions under which the types of ware were made, and in the amounts of water used in compounding the mixtures.

Summary of Results Obtained with Clay No. 1, from Iva Valley, Enugu

Sewer Pipes.—Sewer pipes of fair quality can be made from suitable mixtures of the clay No. 1 with felspar. The proportions of these materials used in combination would depend on the composition of the felspar employed, which should be added in such amount that the fired body shall contain about 5 per cent. of fluxes. Potash-felspars are usually employed in the ceramic industry, but any felspar of reasonable purity should give results comparable with those obtained at the Imperial Institute. The physical properties of the pipes are improved by the addition of 10 per cent. of grog, the shrinkage and the tendency to blister both being reduced, while the resistance to mechanical shock is increased. Salt-glazing of the pipes would need considerable care, as the temperature necessary for this operation is very little below that at

which deformation of the ware takes place, and strict control of the kiln temperature is therefore of the greatest importance. The reaction taking place during the operation of salting is endothermic and there is usually a tendency on the part of the operator to increase the fire at this point in order to make up for the heat lost. Such a procedure with this clay and felspar mixture might be inadvisable, since, unless care were exercised in refuelling, the temperature might possibly be raised unduly.

In this instance it is advised that the fire holes in the kiln should be thoroughly cleaned and a good fire maintained for some time prior to the application of the salt, and that the necessary refuelling should be carried out at the end of each salting period, the fuel being added in small quantities at frequent intervals. When the maximum temperature has again been reached, some little time should elapse before a fresh charge of salt is added. If these precautions are observed no difficulty should be experienced in producing pipes comparable with those made during the course of the present experiments. The colour of the glazed pipes made under these conditions would be considerably darker than those usually employed in commerce, but there is no reason why they should not prove entirely satisfactory in use.

By using the neat clay for the manufacture of salt-glazed pipes considerable economy could be effected and the very careful temperature control of the kiln, which is essential in the case of the felspar mixture, would not be necessary owing to the longer vitrification range of the material. The disadvantages of this procedure would be the high porosity of the fired body, its low mechanical strength, and that pipes so made would absorb liquids when the glaze was broken, and hence could not be used satisfactorily in place of true impermeable stoneware. The neat clay, however, if covered with a hard felspathic glaze, might find some use for the formation of open channels and similar pieces, where great mechanical strength is not essential.

Sanitary Ware.—Good-quality sanitary ware can be made from a mixture of the clay with felspar, in such proportions as will ensure the fired body containing about

5 per cent. of fluxes. Such a body, covered with a hard matt or white opaque glaze, should prove satisfactory for local use.

If it is desired to manufacture massive pieces that would not be subjected to any great mechanical strain, it is probable that the neat clay, covered with a matt or opaque glaze, would yield products suitable for local use. Such a procedure would reduce manufacturing costs, and less care in drying and firing would be necessary than is the case when the felspathic mixture is used. It should be remembered, however, that the body of such goods would not be impermeable, and their useful properties would depend on the efficiency of the glaze.

Paving Tiles.—Good-quality paving tiles of light grey colour can be made from a mixture of the clay with felspar in the proportions stated above (see p. 483). Such tiles have high compressive strength (see Table XI) and resistance to abrasion, whilst their water absorption is very low.

Fine Stoneware.—Fairly good fine-quality stoneware can be made from a mixture of the washed clay and felspar, the proportions being such that the fired body contains about 5 per cent. of fluxes. The ware is free from iron spots and is of good texture.

Wall Tiles.—Wall tiles of fair quality can be made from the washed clay, but a much stronger product is obtained from a mixture of 85 per cent. washed clay and 15 per cent. ball clay. Tiles made of such a mixture, although of a very porous nature, should, when glazed, be suitable for local use.

It would probably be necessary, before glazing the ware, to dip the biscuit in water in order to prevent the adherence of too thick a covering of glaze.

Clay No. 2, from Ozobolo

Preliminary Trials.—Tests showed that the clay was deficient in plasticity, and it was impossible to shape it on the jigger and jolley or to extrude it by means of an auger machine. Small hand-made test bars when fired to approximately 1,280° C. yielded a dark chocolate-brown body showing signs of partial vitrification. Washing

the clay effected no improvement in colour, as would be anticipated from the results of the chemical analysis, which show a higher percentage of ferric oxide in the washed than in the unwashed material.

The results obtained in these preliminary experiments indicated that the raw clay might possibly be suitable for the manufacture of vitrified paving tiles and engineering bricks, and the further tests carried out were directed to the production of such articles.

A determination of the vitrification range of the crude clay gave the results shown in Table XVII.

TABLE XVII

VITRIFICATION RANGE OF OZOBOLO CLAY (No. 2)

Maximum Firing Temperature.	Porosity. Per cent	Colour	Warpage
1,000° C.	34·2	Light terra-cotta	nil
1,050° C	33·2	,, ,,	,,
1,100° C	27·0	Dark ,, ,,	,,
1,150° C	32·8	Light chocolate brown	,,
1,200° C	17·4	Chocolate brown	,,
1,250° C	15·6	Dark chocolate brown	,,
1,300 °C.	15·0	Dark purplish brown	Slight

These results showed that though impermeable stoneware could not be produced from the crude clay at the temperature usually employed for such ware, a considerable reduction in porosity took place.

Paving Tiles.—The clay used for these experiments was ground to pass a sieve having 30 meshes per linear inch, and after tempering with water it was allowed to age for 24 hours. Moulding was carried out by the stiff plastic method, with a hand-power screw press, equipped with metal moulds and dies. The moist clay pressed extremely well, producing good clots with well-defined edges.

Test pieces made by this method were stacked to dry in open chequer work at room temperature, no attempt being made to control the humidity of the surrounding atmosphere. No tendency to warp on drying was observed. The test pieces were fired at 1,200° C., this temperature being considered the maximum which it was reasonably safe to employ without risk of deformation. The results

of tests carried out on these experimental tiles are shown in Table XVIII.

TABLE XVIII

TESTS ON PAVING TILES FROM OZOBOLO CLAY (No. 2)

Water of formation	*per cent.*	18·4
Maximum firing temperature	*degrees C.*	1,200
Duration of firing at maximum temperature	*hours*	6
Drying shrinkage (linear)	*per cent.*	5·8
Firing " "	" "	4·7
Total " "	" "	10·5
Porosity	" "	17·4
Water absorption	" "	8·5
Colour		Dark red
Ring		Good

The hardness of the specimens was such that they could with difficulty be scratched with a steel knife, though their porosity was much higher than that of good-quality stoneware.

A series of test pieces, tested for transverse and compressive strength, gave the following results :

TABLE XIX

Specimen.	MODULUS OF RUPTURE. Span = 5 in. Rate of loading = 5 lb. per min.		COMPRESSION TESTS. Area of spec. = approx. 8 sq. in. Rate of loading = 500 lb. per sq. in. per min.	
	Raw Clay	Fired Clay	Cracking Strength	Crushing Strength.
	lb. per sq. in.	*lb. per sq. in.*	*lb. per sq. in.*	*lb. per sq. in.*
1	239	839	4,389	6,131
2	238	854	4,553	6,751
3	255	831	4,401	5,264
4	202	902	3,773	5,554
5	209	958	—	—
6	270	907	—	—
Mean	236	882	4,280	5,925

The modulus of rupture approximates to that of clay No. 1 from Iva Valley.

Attempts were made to obtain paving tiles of higher quality by the addition of felspar to the clay in such a proportion as to bring the total amount of fluxes in the fired body up to about 5 per cent.

Small test bars were formed by the stiff plastic process from a mixture of 100 parts clay and 13 parts felspar.

The vitrification range of this material is tabulated in Table XX.

TABLE XX

VITRIFICATION RANGE OF MIXTURE OF OZOBOLO CLAY AND FELSPAR

Maximum Firing Temperature.	Porosity. *Per cent.*	Colour.	Warpage.
1,000° C.	34·5	Light terra-cotta	nil
1,050° C.	32·0	Terra cotta	,,
1,100° C.	25·0	Dark terra-cotta	,,
1,150° C.	19·6	Light chocolate brown	,,
1,200° C	17·0	Chocolate brown	Slight
1,250° C.	12·0	Dark chocolate brown	,,
1,300° C	8·2	Blackish brown	,,

Small experimental tiles and test pieces made from this mixture were fired at 1,150° C. with the results given in Tables XXI and XXII.

TABLE XXI

TESTS ON TILES FROM OZOBOLO CLAY AND FELSPAR MIXTURE

Water of formation . . .	*per cent*	18·0
Maximum firing temperature .	*degrees C*	1,150
Duration of firing at maximum temperature .	*hours*	6
Drying shrinkage (linear)	*per cent*	4·2
Firing ,, . .	,, ,,	5 5
Total ,, ,, . . .	,, ,,	9·7
Porosity	,, ,,	19·6
Water absorption	,, ,,	9·6
Colour.		Dark red
Ring		Good

Although the temperature of firing was in this case lower than with the crude clay, the total shrinkage was slightly reduced. The porosity was, however, somewhat higher.

TABLE XXII

Specimen.	Modulus of Rupture: Span = 5 in. Rate of loading = 5 lb per min.		Compression Tests: Area of spec. = approx. 5 sq in. Rate of loading = 500 lb per sq in. per min	
	Raw Clay.	Fired Clay	Cracking Strength.	Crushing Strength.
	lb per sq. in	*lb per sq in*	*lb. per sq in.*	*lb per sq. in.*
1	210	848	4 843	5,421
2	187	978	No audible crack	4,353
3	207	901	5,298	5,630
4	208	974	3,849	4,452
5	186	925	—	—
6	236	926	—	—
Mean	206	925	4,663	4,966

It will be noticed that the effect of the addition of felspar to the clay was to render possible the production at a rather lower temperature (1,150° C.), of tiles similar to

those made from the neat clay. Their modulus of rupture was slightly higher than that of the neat clayware (Table XIX), but the compressive strength was somewhat lower.

Engineering Bricks.—A number of small bricks made from the neat clay by the stiff plastic process were fired in a small down-draught kiln in an oxidising atmosphere at a temperature of 1,000°–1,100° C. After some hours "soaking" at this temperature the air supply to the kiln was restricted and the temperature increased to 1,150–1,200° C. This temperature, and the strongly reducing conditions, were maintained for about four hours.

The resulting bricks were of a bluish-black colour, with a metallic lustre. They had a satisfactory compressive strength of 4,653 lb. per sq. in. (mean of four tests). This figure compares favourably with that of fair-quality Staffordshire blue bricks, which range in strength from 4,600 to 7,000 lb. per sq. in.

The total shrinkage of these bricks was 13 per cent., and the water absorption (mean of six tests) 4·4 per cent.

Attempts to make similar bricks at a lower temperature by the addition of felspar to the clay proved unsuccessful, the vitrification range of the material under such reducing conditions being too short to allow of any reasonable control of the kiln. The bricks obtained in the course of these experiments with the clay-felspar mixture indicated that in all probability there would be difficulties in practice if such a mixture were employed owing to the rapid softening of the ware at the firing temperature.

Summary of Results obtained with Ozobolo Clay, No. 2

This clay, which burns to a dark red colour, is more suitable for the production of vitrified bricks and tiles than for stoneware. It is possible to produce paving tiles of fair quality from the crude clay in admixture with felspar, the addition of which permits of the employment of a rather lower firing temperature than if the clay alone is used. Vitrified bricks of a fairly high compressive strength and low water absorption can be made by firing the clay at 1,200° C. under strongly reducing conditions. Such bricks would probably be suitable for work where great strength and low porosity are essential.

Clay No. 3, from Newi

Preliminary Trials.—This clay when fired at 1,280° C. gave a very weak and porous body of a light brown colour. The test pieces indicated that the raw material would probably be unsuitable for making any class of clay ware.

Small test bars made from the washed clay, which was very sticky and difficult to shape, were fired at 1,280° C. The fired products, which were of a light brown colour, had a total shrinkage of about 20 per cent., and were cracked and split badly.

The very low percentage of fluxes in both the raw and washed clays and the bad colour of the fired bodies indicated that the clay would not be suitable for the manufacture of even common stoneware. It was also found impossible to extrude or mould either clay satisfactorily, the raw clay being non-plastic and the washed clay too sticky. The only way in which the raw clay could be easily moulded was by means of the stiff plastic process.

Paving Tiles.—The above factors indicated that the only use to which this clay could be put, apart from the manufacture of bricks, was the production of paving tiles. For this purpose the addition of felspar in such a proportion as to bring the total amount of fluxes in the fired body up to about 5 per cent. would, in this case, be necessary. A mixture of 100 parts raw clay, previously ground to pass a sieve having 30 meshes per linear inch, and 40 parts of finely ground felspar was then made and allowed to age for 24 hours. This mixture would yield a fired body of approximately the following composition :

TABLE XXIII

COMPOSITION OF FIRED BODY FROM NEWI CLAY AND FELSPAR

		Per cent.	
Silica	SiO_2	70·79	
Alumina	Al_2O_3	18·45	
Ferric oxide	Fe_2O_3	4·43	
Titanium dioxide	TiO_2	1·35	
Lime	CaO	0·48	5·02
Magnesia	MgO	0·41	
Potash	K_2O	3·04	
Soda	Na_2O	1·09	

Small test bars were made by the stiff plastic process and the vitrification range was determined with the results shown in Table XXIV.

TABLE XXIV

VITRIFICATION RANGE OF NEWI CLAY AND FELSPAR

Maximum Firing Temperature.	Porosity. Per cent.	Colour.	Warpage.
1,100° C.	22.3	Light brown	nil
1,150° C	17.6	Reddish brown	,,
1,200° C	14.9	Dark reddish brown	,,
1,250° C.	10.8	Brown	,,
1,300° C.	10.5	,,	,,

The porosity at 1,300° C. was higher than that of ordinary stoneware.

A further series of test bars fired at 1,250° C. gave the results shown below in Tables XXV and XXVI.

TABLE XXV

Water of formation	*per cent.*	14.7
Maximum firing temperature. .	*degrees C.*	1,250
Duration of firing at maximum temperature	*hours*	6
Drying shrinkage (linear)	*per cent*	2.5
Firing ,, ,, . . .	,, ,,	3.7
Total ,, ,, ...	,, ,,	6.2
Porosity (mean of six tests)	,, ,,	10.8
Water absorption (mean of six tests) .	,, ,,	4.9
Colour		Dark brown
Ring		Good

The shrinkage in this case was low, but the porosity was much higher than that of good stoneware. The hardness of the specimens was such that they could hardly be scratched with a steel knife.

TABLE XXVI

MODULUS OF RUPTURE

	Span = 5 in	Rate of loading 5 lb per min.
Specimen.	Raw Clay	Fired Clay.
	lb per sq. in	*lb. per sq. in.*
1	322	1,138
2	308	1,220
3	263	1,192
4	278	1,162
5	284	1,184
6	302	1,142
Mean	293	1,173

It will be observed that the modulus of rupture was in this case superior to that of ware made from clay No. 2.

Summary of Results of Tests on Clay No. 3, from Newi

The clay is unsuitable for the manufacture of stoneware on account of its lack of fluxes and the bad colour of the fired ware which it will yield. Paving tiles of fair quality, brown in colour, can be made from a mixture of the raw clay with felspar. Such tiles, whilst inferior in their appearance and properties to English-made flooring tiles, would probably be suitable for local use.

SOILS FROM THE BRITISH SOLOMON ISLANDS PROTECTORATE

Four samples of soil received from Mr. R. J. A. W. Lever, Government Entomologist, British Solomon Islands, have recently been examined at the Imperial Institute, and as no published information appears to be available regarding the soils of these islands, an account of the results obtained may be of interest.

The samples had been taken on Malaita Island from a block yielding very poor crops of coconuts. The land, which is situated about half a mile from the sea and is about 200 ft. above sea-level, has received no manuring or cultivation for many years past, and the trees are about 15 years old. The annual rainfall is from 80 to 120 in. and the humidity is 80 to 85 per cent.

The soil samples received for examination, which had been taken at four successive 6-in. depths from the surface, were as follows :

No. 1. Surface soil, to 6 in. depth, a heavy clay soil, dark brown in colour.

No. 2. Sub-soil, 6 in. to 1 ft., a very heavy clay soil, dark brown in colour.

No. 3. Sub-soil, 1 ft. to 1½ ft., a very heavy clay soil, dark brown in colour.

No. 4. Sub-soil, 1½ ft. to 2 ft., a very heavy clay soil, brown in colour, distinctly lighter in colour than the first three.

All the soils became very sticky when wet.

Results of Examination

The air-dried samples were submitted to partial chemical and mechanical analyses with the results shown in the following tables.

The clay fraction separated from sample No. 4 after mechanical analysis was also submitted to chemical analysis.

Preliminary Mechanical Analysis on the Entire Soil, which was Air-dried before Examination

(Percentages)

—	Size of Particles in mm	No. 1.	No. 2.	No. 3.	No. 4.
Stones and gravel	Over 2·0	0·1	trace	0·3	trace
"Fine earth"	2·0 and under	99·9	100	99·7	100

Mechanical Analysis of "Fine Earth"

(Percentages)

—	Size of Particles in mm	No. 1.	No. 2.	No. 3.	No. 4.
Coarse sand [1]	2·0 to 0·2	6·7	2·7	2·1	2·6
Fine sand [1]	0·2 to 0·02				
Silt [1]	0·02 to 0·002	13·6	5·8	5·8	7·8
Clay [1]	0·002 and under	61·0	75·1	73·3	83·3
Moisture at 105° C.		18·28	16·70	18·73	6·18
Matter soluble in water		0·07	0·03	0·03	0·04
Calcium carbonate		nil	nil	nil	nil
Loss on ignition (not including moisture at 105° C.)		14·18	12·95	11·68	13·97
Reaction of soil		Almost neutral	Very faintly acid	Very faintly acid	Faintly acid
*p*H value (indicator method)		6·95	6·8	6·7	6·5

[1] *Fractions dried at* 105° C.

Partial Chemical Analysis of "Fine Earth" Soluble in Hydrochloric Acid

		No. 1. Per cent.	No. 3. Per cent.	No. 4. Per cent.
Lime	CaO	0·30	0·22	0·21
Magnesia	MgO	0·51	0·30	0·28
Potash	K_2O	0·04	0·03	0·06
Soda	Na_2O	0·05	0·04	0·05
Phosphoric acid	P_2O_5	0·24	0·30	0·41
Ferric oxide	Fe_2O_3	16·40	15·29	18·41
Manganous oxide	MnO	1·55	0·36	0·47

The acid-soluble material in soil No. 2 was not determined, on account of the small size of the sample.

Available Portion (i.e. Portion Soluble in 1 per cent. Citric Acid Solution)

		No. 1. Per cent.	Nos. 2, 3, 4. Per cent.
Phosphoric acid .	P_2O_5	0·003	not determined

Other Constituents Determined

		No. 1. Per cent.
Nitrogen (total) . . .	N	0·22
Organic carbon . . .	C	2·00
Organic matter[1] . . .		3·64

[1] *Obtained by multiplying the figure for organic carbon by* $\frac{100}{55}$.

Chemical Analysis of Clay Fraction (of diameter 0·002 mm. and under) Separated by Sedimentation from Sample No. 4

Results calculated to moisture-free basis

		Per cent
Silica . . .	SiO_2	32·32
Alumina	Al_2O_3	29·86
Ferric oxide	Fe_2O_3	21·32
Titanium dioxide . . .	TiO_2	1·56
Manganous oxide . . .	MnO	0·30
Lime	CaO	not detected
Magnesia	MgO	0·66
Loss on ignition . . .		14·45
		100·47

$$\text{Molecular ratio } \frac{\text{Silica, } SiO_2}{\text{Alumina, } Al_2O_3} = 1{\cdot}83$$

Mineralogical Examination of Sand Fractions

The sand consisted mainly of very fine magnetite, with some quartz and traces of hornblende, etc.

Remarks

These four samples of soil and sub-soil are all of an extremely heavy character, the amount of clay being unusually high. The very low proportion of silt to clay in the three sub-soil samples (Nos. 2, 3 and 4) is also noteworthy. The amount of moisture retained by the air-dry soil is high in the first three samples (Nos. 1 to 3), as would be expected in soils containing so much clay, but is low in No. 4, considering the nature of the soil. Water-soluble salts are low in amount in all cases. The reaction of the soils is almost neutral or very faintly acid, the acidity showing a slight tendency to increase with depth.

From a chemical point of view, the soils are poor. The amounts of acid-soluble lime are low, especially for heavy soils, and are exceeded slightly by those of the magnesia, a condition which is often regarded as indicating poor fertility. The percentages of acid-soluble potash are

low, although this constituent might be expected to be present in fair quantity in a heavy clay soil. The soils contain large proportions of iron compounds readily soluble in acid and there is also a good deal of manganese present, especially in the surface soil, which gave indications that the greater part of the manganese is probably present as some form of manganese dioxide.

The amounts of acid-soluble phosphoric acid are low and very little of this constituent is present in the "available" form, the small quantity which occurs in the acid-soluble state being probably rendered relatively insoluble by combination with the iron present.

The percentages of nitrogen and of organic matter may be regarded as satisfactory.

The composition of the clay fraction separated from No. 4 shows a high proportion of ferric oxide, which, considered in relation to a ratio of silica to alumina of less than 2, indicates that the soil, on the basis of the classification proposed by Martin, may be regarded as of a lateritic type.

Although chemically this soil must be regarded as poor, it is unlikely to repay artificial manuring, as the main cause of the poor crops produced probably lies in its physical character, which is unusually heavy. It appears quite likely that under a heavy rainfall the soil would become water-logged, and drainage would undoubtedly be very poor. This heavy condition is so pronounced that any of the usual practices for lightening soil, such as green manuring or liming, would not be likely to make sufficient improvement to be worth the time and expenditure involved.

ARTICLES

EMPIRE FIBRES FOR MARINE CORDAGE

In a previous Admiralty report on tests of cordage made from Manila and Sisal hemps (Bulletin of the Imperial Institute, 1933, **31**, 30), it was mentioned that in order to encourage the use of Empire fibres for the manufacture of marine cordage, tests have been carried out by the Admiralty for some years, in conjunction with the Imperial Institute Advisory Committee on Vegetable Fibres, to

ascertain the degree to which ropes manufactured from Empire hemps could resist the action of sea-water as compared with ropes made from Manila. The present report deals with tests made with New Zealand hemp cordage; for the results of investigations with this rope conducted by the Imperial Institute reference may be made to the BULLETIN OF THE IMPERIAL INSTITUTE (1931, **29**, 1–31; 1932, **30**, 119–124).

TESTS OF CORDAGE MADE FROM NEW ZEALAND HEMP

REPORT OF LARGE-SCALE TRIALS CARRIED OUT BY THE ADMIRALTY 1932–33

1.—The trials of New Zealand hemp have now been in progress since 1926. The first stage of the trials demonstrated that cordage made from New Zealand hemp was capable of withstanding the action of sea-water over prolonged periods. In view of this the New Zealand authorities requested that further trials should be made, and in 1929–30 the following quantities of New Zealand hemp were supplied for further tests:

	cwts.	qrs	lb.
Grade "B" Fine	5	0	21
,, ,, Good Fair	4	5	9
,, ,, High Point Fair	3	3	26

This was made into 3-in. cordage, and issued for trial in August 1929. The results of these trials in comparison with Manila were summarised as follows:

"(1) The best of the New Zealand grades is 'high point fair.'

"(2) None of the grades can be regarded as suitable for the manufacture of Admiralty cordage in view of their low initial tensile strength.

"(3) Fibre somewhat same colour as Manila but rather coarser.

"(4) All grades capable of withstanding the action of sea-water over prolonged periods although hardly up to the standard of Manila.

"(5) When immersed in sea-water all New Zealand grades—

(*a*) Absorb water at a quicker rate than Manila and sink more rapidly.

(*b*) Swell more and remain swollen when subsequently dried.

"(6) When cordage is in use as boats' falls it renders easily, but when wetted it becomes greasy and requires careful handling. An extra turn, well backed up, is required to lower a boat."

In view, however, of the comparatively good performance of 'fair' and 'high-point fair' grades of New Zealand hemp in these (Admiralty) and the Imperial Institute tests, it was decided in spite of (2) above to carry out a large-scale service test in H.M. Navy on similar lines to that undertaken for sisal ropes.

For this purpose the following grades were supplied by the New Zealand authorities:

High Fair	64 bales	Total 30 tons.
Low Fair	76 ,,	
Young Leaf	13 ,,	

Each grade was kept separate and made up into cordage with distinctive marks.

The whole of the fibre was grown naturally in the Makerua district on well-drained peat about 30 ft. above sea-level. The "High Fair" and "Low Fair" were six years old and the "Young Leaf" four years.

2. **Yarn Tests.**—The average breaking loads of the yarn after making up into cordage were as follows, in each case the average of ten tests being shown, and three series were carried out with each size:

—		High Fair	Low Fair	Young Leaf	As specified for Manila in T G 30, not less than
		lb	lb	lb	lb
25 thread	1	180·5	166·5	186	190
	2	181·5	180 5	185	
	3	191	183	182	
30 thread	1	154 5	172 5	164·5	155
	2	155	163	157	
	3	165·5	167 5	171 5	
40 thread	1	113	99	94·5	100
	2	102	103	98·5	
	3	108	99	100	

It will be noted that the yarn breaking loads do not in all cases reach those specified for Manila, but the deficiencies, where they exist, are not large.

3. **Breaking loads,** obtained from the cordage immediately after manufacture, were as follows. The three averages shown are of ten tests in each case :

Size		High Fair		Low Fair		Young Leaf		As specified for Manila in T G 30, not less than	
		Tons	*Cwts*	*Tons*	*Cwts*	*Tons*	*Cwts*	*Tons*	*Cwts.*
5 in	1	11	3	12	6	11	11		
	2	10	18	11	19	11	0	10	5
	3	11	5	12	2		—		
4½ in	1	8	12	8	10	8	18		
	2	8	10	8	12	9	0	8	10
	3	8	14	8	14		—		
4 in	1	7	8	8	10	6	17		
	2	7	11	7	15	7	3	6	15
	3	7	7	6	0		—		
3½ in	1	5	18	5	7	5	14		
	2	5	13	5	14	5	17	5	5
	3	5	17	5	12		—		
3 in	1	5	8	4	7	4	3		
	2	5	9	4	7	4	5	4	0
	3	4	19	4	2	4	7		
2½ in	1	3	9	3	1	3	6		
	2	3	11	3	4	2	19	2	15
	3	3	8	2	19	3	2		
2 in	1	2	1	2	1	1	16		
	2	2	5	1	19	1	19	1	15
	3	2	3	[illegible]	2	1	19		
1½ in	1	1	5	1	2	1	0		
	2	1	10	1	3	1	2	1	0
	3		—	1	1	1	0		
1 in	1		11		10		10		
	2		11		11		10		10
	3		—		—		—		
¾ in	1		8		8		8		
	2		7½		7½		7½		7½
	3		8				—		
½ in	1		4½		3¾		3¾		
	2		4		3¾		3¾		3¾
	3		—		—		—		

4. **Weights per coil.**—In all cases the weight of the finished coils was within the tolerance laid down in the Manila Specification, T.G.30.

5. **Services for which used.**—The fibre was made up into

cordage of sizes 6 in. circumference and below, and it was issued to the Royal Dockyards and to vessels in Home, Mediterranean, China Fleets, and to isolated vessels in other fleets, also to vessels serving under the New Zealand Government.

It was issued as a substitute for Manila cordage and in some instances in lieu of tarred cordage made from European hemp. Instructions were issued for the cordage to be closely examined during its use, particularly as regards its flexibility and ease of handling, and for difficulties due to swelling or defects arising from mildew.

The services for which the cordage was used during the trials were as follows :

(*a*) Whalers' Boats' Falls in selected vessels.

(*b*) Towing, heaving and securing lines, awning lacings, deck tackles, derrick tackle and guys, breast ropes, boats' rigging, ammunition whips, etc.—all these services being exposed to weather conditions.

6. Results of trials.

I. *Boats' falls.*—3-in. cordage was used for this purpose. The usual Naval practice is to use tarred cordage made from soft European hemp for use as boats' falls. The results compared closely with those obtained from Sisal, the objectionable features being :

(1) Shows a tendency to stretch abnormally when under load, and to unlay.

(2) Becomes greasy when wet and special care is required when lowering boat.

(3) Swells, but not sufficiently to choke the blocks. Signs of mildew appeared in one case on the China Station during the wet season.

Many reports were favourable, and the boats' falls were used throughout the normal period of service. Only one case was reported of a boats' fall parting, but in this instance the cordage had been in use for the long period of eleven months.

In view, however, of the importance of this service, and the danger to life and limb involved, it is not proposed

by the Admiralty to use New Zealand hemp for boats' falls until further experience has been gained on services of lesser importance.

II. *For other services.*—About 100 reports were received from ships and shore services. In the great majority of cases these were definitely favourable. It was reported that all grades were easy to handle with average flexibility and with one exception, on Africa Station, no signs of mildew were experienced. Cases were reported indicating that the cordage showed a tendency to chafe, reduced in size under stress, was slippery when wet and slightly less springy, swelled when wet although not sufficiently, except in one case, to cause any jamming in the blocks. A few reports indicated a tendency to fray and whisker, and to discolour quickly.

In three instances the cordage parted. In two of these cases it was in connection with awning lacings, the size being $\frac{7}{8}$ in. and 1 in. circumference, and the parting occurred where the cordage had chafed and when it was being tightly laced. The grade of fibre in these cases was not reported. The other case related to a 5-in. breast rope made from High Fair. This parted without any undue strain after four months' use, and it was reported that a portion was badly affected by mildew. The vessel concerned was serving on the West Coast of Africa where mildew is reported as being peculiarly prevalent. This defective cordage was forwarded to England and subjected to close examination, and it is reported that the condition of the cordage at the point of fracture shows evidence of a cut as if caused by a sharp instrument which had severed one strand.

The following report was received from one vessel on samples of High Fair and Low Fair :

(1) Very flexible and easy to handle.
(2) Does not deteriorate noticeably from exposure.
(3) Does not swell sufficiently to make its working in a block difficult.
(4) Stretches rather more than Manila.
(5) No mildew noticeable.
(6) Soft laid and easy to splice.

This summary can be regarded as typical of a large number of the reports, and it applies to all the grades of fibre tested. No noticeable distinction could be drawn from the three grades (High Fair, Low Fair and Young Leaf) of cordage supplied.

7. **Recommendations.**—The situation with regard to New Zealand fibres compares closely with the final report on Sisal, viz.: that if New Zealand and Manila were on an equal footing as regards origin, the result of the trials would not warrant any change in present practice.

As, however, the policy of the Admiralty is to give a preference to products of the Empire, the results are sufficiently encouraging to warrant its partial adoption in conjunction with Sisal so long as supplies can be obtained at satisfactory prices, and the fibre is sufficiently strong to give the yarn and cordage breaking strains specified in the Government Departmental Specification for Manila cordage, T.G.30.

Arrangements are, therefore, being made for New Zealand to be considered in conjunction with Sisal, when purchases are being made for the services indicated in the report on Sisal (BULLETIN OF THE IMPERIAL INSTITUTE, 1933, **31**, 38–39), viz.:

(*a*) 50 per cent. of requirements for:
Towing hawsers.
Heaving and hauling lines.

(*b*) Entirely for:
Side screen martingales.
" " outhauls.
" " topping lifts.
" " inhauls.
" " tackles.
Hemp hook ropes.
Coaling whip outhauls.
Dressing line whips (tailing).
Sounding spar outhauls.
Anchor buoy ropes.
Collision mat lowering lines.
Nose and tail lines for torpedoes.
Awning lacings.

Heaving lines for boat ropes.
Creeper ropes.
Awning ear-rings.
Coaling whip downhauls.
Dressing line downhauls.
Sounding spar martingales.
Compressor falls.
Guest warps.
Burton falls.
Lacings for canvas fixtures, small awnings, blast screens, side screens, windsails, boats' covers, canopies, tarpaulins, etc.

8. If New Zealand cordage continues to give satisfactory service, and New Zealand hemp is obtainable at prices which compare satisfactorily with those of British East African Sisal and/or Manila, the question of its more general adoption will receive consideration.

THE DEVELOPMENT OF COFFEE PRODUCTION IN THE EMPIRE

During the present century the production of coffee in the British Empire has increased from approximately 12,000 to 50,000 tons per annum. In the same period the total world's production has grown from roughly one to two million tons, so that although the Empire output has increased by over 300 per cent. its share in the world's production has only risen from about 1·2 to 2·5 per cent. The part played by the Empire in the world's trade in coffee is thus very different from its rôle in the tea and cocoa industries to which the Empire contributes about 70 and 60 per cent. respectively of the world's supplies.

Coffee production, however, is not a new arrival amongst Empire tropical industries; in fact it is one of the oldest. More than two centuries ago the pioneering work in growing coffee outside Abyssinia and Arabia was shared by the French and British in the West Indies, and the Dutch in the East Indies. In the early years of the nineteenth century the British West Indies (Jamaica, Dominica, Trinidad and British Guiana) had an annual production amount-

ing to a maximum of some 20,000 tons. The emancipation of the negroes was a heavy blow to this industry which rapidly declined after about 1840. About this same time the suitability for coffee cultivation of the hill country of Ceylon was proved and by 1875 that Colony had reached its maximum production of some 50,000 tons, to be followed shortly by South India with a production of 25,000 tons.

Whilst the West Indian industry succumbed to labour costs, that of Ceylon and of the Dutch East Indies fell before the attack of the coffee leaf disease (*Hemileia vastatrix*). In South India the disease has not proved so virulent, although it persists as a menace and a cause of considerable expense to the industry.

Towards the close of the nineteenth century British Malaya developed an industry in Liberian coffee to the extent of some 6,000 tons per year, which later gave way to the superior attractions of Hevea rubber. Had these various parts of the Empire been able to maintain, even without any further increase, the highest outputs reached during their careers as coffee producers, the Empire contribution to the world's supply of coffee at the beginning of the present century should have been some 100,000 tons, Yet as already stated it was only about 12,000 tons and the recent increase to 50,000 has been almost entirely due to developments in tropical East Africa—Kenya, Uganda and Tanganyika—which area now produces some 30,000 tons of coffee.

The troubles encountered in the East and West Indies helped to encourage coffee production in South and Central America, first in Brazil and later in Colombia, Guatemala, El Salvador, Venezuela, etc. The developments have been so great that this region now produces about 75 per cent. of the world's supply. Brazil predominates to the extent of producing 60 to 70 per cent. of the total, the estimated crop for 1933–34, a favourable year, being the enormous amount of 30,000,000 bags (132 lb.) or approximately 1,768,000 tons. In commerce Brazilian coffee forms a class by itself in distinction to the " mild " coffees of Colombia, Guatemala, etc. Whilst the " mild " coffees are of higher commercial value their price is affected by the quantity of the " bulk " Brazilian coffee on the market. Periodically during the

last thirty years the output of Brazilian coffee has been so great that various valorisation and defence schemes have been put into operation to maintain prices artificially. The scheme now in operation, under the control of the National Coffee Council, provides for the destruction of surplus stocks, and in the period between July 1931 and October 15, 1933, no less than 23,593,000 bags (of 132 lb.) or 1,390,302 tons of Brazilian coffee have been so destroyed mainly by burning or dumping in the sea.

The situation to be faced by Empire coffee producers is that there is in the world a demand for two principal grades of coffee, i.e. for a very large amount of the cheaper Brazilian type, and for a much smaller amount of the higher grade and more expensive " mild " coffees of which Colombia is the largest producer.

The history of coffee in the Netherlands East Indies provides an interesting example of how the problem can be solved. From 1711 onwards the production of Arabica coffee increased greatly until it was checked by the incidence of coffee leaf disease about 1880. The next twenty years witnessed a rapid decline, the industry being almost exterminated. Liberica coffee, which had been introduced in 1876, also proved susceptible to the disease and its cultivation likewise fell. In 1900 Robusta was introduced and its great resistance to leaf disease and its high productivity, coupled with good scientific work and high estate efficiency, have restored coffee to the position of a staple export crop. In 1931 the exports of coffee from the Netherlands East Indies were 69,792 tons, of which no less than 60,791 tons, or 87 per cent., were Robusta. Liberica and allied varieties are grown at low elevations, and on heavy soils ; Robusta chiefly on lighter soils at elevations between 1,000 and 2,500 feet ; whilst Arabica thrives best on volcanic soils at still higher altitudes where it is less susceptible to leaf disease.

In the following pages an attempt is made to indicate the lines Empire countries are pursuing. South India and Jamaica continue the cultivation of Arabica owing to the high quality of their produce. The East African (Kenya) Arabica coffees grown in the highlands are also of the " mild " class and hold their own with the produce of

Colombia, Costa Rica, etc. In other countries which have not suitable highlands, only an inferior grade of Arabica can be obtained which has to compete with the lower-priced Brazilian coffee. In such localities, as also in places where Arabica is very subject to leaf disease or where labour conditions are difficult, the more satisfactory crop is undoubtedly Robusta, because although it ranks in price with ordinary Brazilian, it is a much heavier yielder, is resistant to leaf disease and makes much less demands on labour.

In special circumstances Liberica can be grown, but the market for it, principally in the Scandinavian countries, is more restricted than for Robusta.

Excelsa is a coffee to which more attention might be given, especially in localities which, owing to poor soil conditions and to low or badly distributed rainfall, are not suitable for Arabica or Robusta. In 1917 the Imperial Institute reported on a sample received from the Director of Agriculture, Trinidad, as likely to be " readily saleable in the London market at prices similar to those ruling for Liberian and Robusta coffees." Interest in Trinidad had been aroused by the manner in which a plot of Excelsa had withstood very severe droughts which had very seriously affected an adjacent plot of Robusta. Quite recently Dr. P. J. S. Cramer (*see* Bibliography) has urged the advisability of using Excelsa to replace part of the Arabica in Annam and Tonkin, where the latter species does not give good results.

The present position in the Empire is briefly that Arabica of a good " mild " type is being produced commercially in South India, Jamaica, Kenya, Uganda, and Tanganyika ; Robusta in Uganda, Tanganyika and Trinidad, and on a smaller scale in several other colonies ; Liberica in British Guiana and British Malaya.

Much work is being done by Departments of Agriculture and planters' organisations to promote the welfare of the industries, the problems facing which differ in different colonies. The steps taken include not only scientific research but attention to co-operative and other means of improving the preparation and marketing of the product.

The appended bibliography will indicate sources of more detailed information on Empire coffee than it is possible to give in this short survey.

JAMAICA

Coffee in Jamaica has a history of more than two centuries, it having been introduced about 1720 and soon taken up as a commercial crop. The age and early importance of the industry is shown by the fact that the exports reached a maximum of over 13,000 tons in 1814, that is one year before Ceylon became a British Colony and fifteen years before the first coffee estate was established in South India. During recent years, developments in tropical East Africa have reduced Jamaica from second to fourth in the list of Empire producing countries. The Jamaica exports during the present century have themselves declined from an annual average of about 4,250 tons in the first five years to 3,600 tons in 1928 to 1932. Amongst the causes for this fall are low prices, droughts, hurricanes, labour shortage and soil erosion. The last trouble is one that already threatens the comparatively new coffee industries of Africa, and it may be useful as a warning, to indicate the extent to which coffee estates may be ruined by neglecting to care for soil preservation, to quote from Mr. A. St. G. Spooner's account in 1915 of the Blue Mountain coffee industry. "The lands on which the plant is grown are generally very steep hillsides, and in many places the soil is now insufficient (owing to denudation) and too poor to produce profitable coffee bushes, except in little valleys and pockets where there is still depth and suitable quality of soil. It is stated that an estate having perhaps 1,000 acres, at one time or another suitable for coffee, might to-day find it difficult to maintain 100 to 150 acres."

Two classes of coffee are produced in Jamaica, the famous "Blue Mountain" and the ordinary settlers' coffee. "Blue Mountain" is grown at an elevation of 2,000 to 4,000 feet; but above 2,500, although the quality is better, the heavy rainfall makes flowering irregular, and the yield is lower. There are only a few surviving actual coffee estates and they prepare their own grown coffee together

with that purchased in the cherry from small cultivators in the same districts.

The ordinary coffee is largely grown by the peasantry, often as an item of mixed cultivation, at elevations below 2,000 feet including the foothills of the Blue Mountains. During recent years improvements in the industry have resulted from the working of the Produce Protection Law. Pulpers have been installed and the co-operative handling of settlers' coffee encouraged. Efforts are being made to extend the industry amongst the peasantry.

Trinidad and Tobago

Arabica coffee, commonly known as Creole coffee, has long been grown in Trinidad. In 1792, the year before it became a British possession, there were 130 coffee estates with a production of about 150 tons. Subsequently production declined, and at the beginning of the present century coffee was mainly grown casually in odd places on cocoa estates. Comparatively recently there has been a revival of interest in coffee, increased by the fall in price of cocoa. Arabica, and to an increasing extent Robusta (introduced by the Royal Botanic Gardens in 1897) are being grown, in a few cases as a sole crop but chiefly for filling in blank spaces in cocoa. The higher price obtained for the Arabica is not sufficient to offset the far larger returns of Robusta, which also makes less urgent demands on labour at the picking season. Excelsa coffee, introduced in 1905, has proved suited to conditions too dry for Robusta. In damp localities it is very susceptible to the South American leaf disease (*Omphalia flavida*).

From 23 tons per annum for the first five years of the century, the exports of coffee have risen to an average of just under 300 tons for the years 1928 to 1932. The production is capable of considerable increase even without additional planting were coffee treated more seriously than at present by many planters.

Leeward Islands

Dominica alone of the Leeward Islands has now natural conditions suitable for coffee cultivation on any considerable scale. Long ago Arabica coffee was in fact the chief

product of the island. It is estimated that in 1791 the annual crop was about 2,000 tons. By 1823 it had fallen to 972 tons, and continued to decline very rapidly.

Mr. Naftel in his interesting report of 1898 attributed the practical extinction of the industry to wars and political disturbances, the high price of sugar, with abolition of slavery as the final blow. A little coffee, Arabica, Liberica, etc., continued to be grown, and during recent years there has been some revival of interest with Robusta chiefly in demand for planting. San Ramon, Excelsa and Stenophylla are also being tried on a field scale. The exports remain trivial in amount, reaching about 15 cwts. in a favourable year.

Windward Islands

Coffee does not appear to have ever been an important crop in Grenada, St. Vincent or St. Lucia. Recently there has been some planting, chiefly of Robusta in both Grenada and St. Lucia. The latter island is also experimenting with " Blue Mountain " coffee.

British Guiana

Well over a century ago British Guiana had a flourishing industry of Arabica coffee, known nowadays as Creole coffee. The exports appear to have reached a maximum of over 6,000 tons in 1821. With the labour difficulties which followed on the abolition of slavery the industry rapidly declined to nothing or very nearly so from 1846 onwards.

At the beginning of this century there was a revival of coffee growing, but of Liberica instead of Arabica. The advantages of Liberica under present conditions are that it is hardy, is more suited to the labour supply, as picking can be spread over a longer period, and thrives on the " pegasse " soils of the Colony. These soils are of a peaty nature, consisting of acid organic matter of varying thickness overlying an acid clay ; Liberica is almost the only permanent crop which thrives on them.

The present industry is located chiefly in the lowlands of the North West District, adjacent to Venezuela, and in one or two other areas, and is carried on by small native

farmers. The exports have increased from about 3 cwt. in 1900 to 470 tons in 1932, with an average for the last five years of 360 tons.

The industry is capable of considerable increase but the present equipment is inefficient and means of securing a better prepared and more uniform product are essential. A small area worked intensively by the farmer and his family "is a sounder proposition than a larger acreage worked with the aid of paid labour." Good land can be made to yield 9 cwts. or more per annum. The Department of Agriculture is devoting attention to the advancement of the industry, including experiments with other varieties, e.g. Robusta.

British Honduras

In the account of his visit to British Honduras in 1882, Dr. (later Sir) D. Morris recorded his favourable opinion of an estate with about 100 acres in young Arabian coffee. The latest *Handbook* on the Colony states that coffee would thrive on the foothills, but might not pay owing to labour shortage.

South India

India maintains its position as the largest producer of coffee in the British Empire. The industry is confined to South India ; the hilly districts of the Madras Presidency, Coorg, and the States of Mysore, Travancore and Cochin. The first plantation was established in 1830, and the area under coffee was at its maximum, approaching 300,000 acres, some 60 years later. During recent years it has remained fairly steady at about 160,000 acres, exclusive of holdings of under ten acres ; in 1931–32 the inclusion of these in the returns made the area about 170,000 acres. Of this total 52 per cent. is in Mysore, 24 per cent. in Madras, 22 per cent. in Coorg, and the remaining 2 per cent. in Cochin and Travancore. The annual production during the five years ended in 1931–32 fluctuated between about 13,000 and 18,000 tons.

The coffee districts lie between 1,000 and 6,000 feet, but mainly between 3,000 and 4,000 feet. The rainfall varies from 55 to 115 inches, 60 inches being more general, with

a comparatively dry season of three to four months ; the temperature range is about 55° to 80° F. Arabica very largely predominates, with some Robusta at the lower levels.

Various named strains of Arabica are grown, e.g. "Chick" or "Chic," probably the original type planted in Mysore, "Coorg," and during recent years "Jackson" and the more popular "Kent." The latter have arisen as local selections mainly on the basis of resistance to *Hemileia* disease. They have proved of great value also in East Africa.

The welfare of the industry has for many years been a part of the work of the United Planters' Association of Southern India, composed of European planters of tea, coffee, rubber, etc., in the States as well as in the Presidency.

Assistance received from the Government of the Presidency is supplemented by an acreage cess on the various crops of the members and the Association maintains its own scientific staff.

In 1925 the Mysore State Department of Agriculture, with financial assistance from the United Planters' Association, opened a Coffee Experiment Station at Balehonnur and from 1928 the Coffee Scientific Officer of the Association has worked at this Station. There is thus now close co-operation between the planters, both European and native, and the governments of South India centred about the Mysore Coffee Experiment Station. The activities of the Station are summarised in the *Review of Agricultural Operations in India*, 1929–30 and 1930–31 (p. 97) in these words : "An effort was made to get growing in the State all the commercially important species and varieties of coffee which might be of any use in breeding work. Selections were made and a considerable amount of hybridising was done. The first definite cross between *C. arabica* and *C. robusta* produced in India has been planted out. The main object of this work is to produce a variety with the quality for which Mysore coffee is famous and resistance against leaf disease and 'die-back.' In addition, work is being energetically carried on with the hope of immediate benefit on manuring, on the investigation of fungus

diseases and insect pests and trials of fungicides and insecticides, and on grafting of scions from selected bushes on to disease-resistant stocks. The first two items of work have already begun to yield results of great practical value, and as regards the last item distinct progress has been made."

The widespread occurrence of coffee leaf disease (*Hemileia*) is a great handicap, two or three sprayings per annum being frequently necessary. The disease also prevents manuring from having its full effect. The breeding of disease-resistant strains is thus greatly to be desired. The problems before the industry are well indicated in the following summary by Mr. W. W. Mayne, the Coffee Scientific Officer of the United Planters' Association, of his recent paper on " The Function of Spraying in Coffee Crop Production."

1. " Control of leaf disease and black rot by direct means are estate works of primary cultural importance over considerable coffee areas in South India. They are likely to remain so until resistant strains are developed and propagated.

2. " The chief limiting factor in crop production over large coffee areas in South India is leaf disease, which, by its destruction of leaf surface, depresses the carbohydrate nutrition of the plant so low that full advantage cannot be taken of the soil supplies of mineral food.

3. " Raising the level of mineral food supplies by manuring under these conditions can give little or no increase in cropping power.

4. " After the initiation of disease control methods, for a time good yields may result from the more efficient utilisation of the mineral food still present in the soil. At the same time, higher yields mean a greater rate of removal of minerals from the soil and the approach of a time when these supplies will be insufficient to maintain yields.

5. " Manuring, except perhaps on very old estates and some other special cases, is to be regarded as an insurance against deterioration rather than, at present, a direct means of increasing crops on estates where disease-control measures have been recently instituted.

6. " Manuring with reference to the minerals removed by the average crop seems the soundest method of maintaining the mineral level in the soil."

Ceylon

The history of the spectacular rise and fall of the coffee industry of Ceylon has often been told, and it will be sufficient to state the facts very briefly. Arabica coffee was introduced by the Dutch about 1690, but it was not until after the conquest of the Kandyan Kingdom by the British in 1815 that the suitability of the hill country to this crop was discovered. Success there was assured by 1838, a wild rush followed and " the coffee mania was at its climax in 1845." A financial crash followed, but the industry was reorganised and from 1855 to 1888 coffee was the staple crop of the Colony. At its maximum, about 1875, the exports amounted to nearly 50,000 tons per annum.

Soil impoverishment and attacks of the " Green bug " (*Lecanium coffeae*) caused trouble and later, from small beginnings in 1869, the hitherto unknown coffee leaf disease fungus (*Hemileia vastatrix*) gradually spread, and was the major cause of the ruin of the industry, reducing the yield to an unprofitable amount and resulting in the wholesale abandonment of estates. To-day the annual production of coffee in Ceylon is only five or six tons in a good season whilst the imports are about 1,300 tons. During recent years attention has been given to the possibilities of Robusta types. Experiments made by the Department of Agriculture with Robusta, Uganda, Quillou, Canephora and Laurentii have not shown any great difference between them as regards vigour, yield or quality of produce, so that " as far as present knowledge goes any of these coffees can be recommended for any district which has conditions suitable for coffee growing." Their cultivation is gradually increasing, mostly by small holders, but also on a few estates. They are grown interplanted and also as a sole crop, and thrive from sea-level to about 3,500 ft. and under a rainfall ranging from 80 to 150 inches.

British Malaya

The cultivation of coffee in British Malaya dates from soon after the introduction of Liberica in 1875 and was greatest in the period 1880 to 1898, during part of which coffee was the principal plantation crop. Good profits were often obtained and the annual export reached a maximum of about 6,500 tons. With the fall in price of coffee and increasing interest in rubber, coffee planting ceased about 1898 and Hevea largely took its place, the coffee being cut out or interplanted. In 1900 Robusta was introduced but made no headway against the superior attractions of Hevea. There are now some 13,000 acres of coffee, mostly planted amongst rubber and coconuts; about 9,000 in the Federated Malay States, 1,000 in the Straits Settlements and 3,000 in Johore. Liberica preponderates, grown chiefly by Asiatics, but some small estates cultivate Robusta. Although some 200 tons of locally grown coffee are exported, the production is far below consumption, the net imports of coffee, largely Robusta from Java, being about 4,000 tons per annum. During recent years the Department of Agriculture has recommended increased production in view of the local demand.

In 1928 an experiment was initiated with the "Kent" variety of Arabica from Mysore, in the Cameron Highlands at an elevation of about 4,700 ft. The early results were promising and a good grade of coffee was obtained. By 1932, however, infection with *Hemileia* set in and longer experience is necessary before the cultivation of Arabica in this area can be confidently recommended.

The taste of the Asiatics in Malaya is reported to favour Liberica, and as this species thrives in the lower lands and yields well when properly cared for, it may prove the more profitable kind to grow.

Seychelles

According to the Department of Agriculture's report for 1932 the cultivation of Robusta has passed the experimental stage in many localities, one of which is producing nearly one ton of parchment coffee per annum. The imports are about 60 tons per annum, which it is considered could be produced locally.

Mauritius

The introduction of Robusta and other disease- (*Hemileia*) resistant coffees was made in 1916. The Department of Agriculture reported in 1928 that much attention is being given to this crop and several plantations of a comparatively large extent had recently been started.

Kenya

Kenya is second amongst Empire coffee-producing countries, although in 1931–32, a year of poor crops in both, it yielded this position to Tanganyika Territory. During recent years the coffee exported has ranged from 9,000 to 14,000 tons, worth about half the total value of the agricultural exports of the Colony. In sharp contrast to Tanganyika and Uganda, where native production has been encouraged and is now important, coffee has been developed in Kenya only as a European or non-native plantation industry.

Coffee was introduced in 1896 and the first plantation begun near Nairobi in 1900. As in all the other countries of British East Africa these early efforts were made by the Missions. Arabica is grown almost entirely, the principal type being "Bourbon," sometimes referred to as the "African Mocha"; there is also some "Nyasa" coffee. Comparatively recent introductions are the "Kent" and "Jackson" varieties from South India and "Blue Mountain" from Jamaica. The plantations lie mainly at an elevation of between five and six thousand feet, and have a rainfall ranging from 35 to 90 inches.

Since 1914 the industry has made constant progress and the quality and reputation of Kenya coffee (marketed as "Nairobi" coffee prior to 1914) are well established.

The industry has had, and still has, many difficulties to contend with. In a recent survey of the position the senior Coffee Officer refers to occasional adverse climatic conditions (mainly droughts), delayed flowering, the serious problem of soil erosion, the menace of various diseases and pests, losses due to bad pruning, etc. In earlier years, but less so recently, labour shortage was often a serious trouble.

The Department of Agriculture has maintained special

Coffee Officers and a staff of inspectors for advisory work and the better control of diseases and pests. Experimental work has also been conducted on such matters as pruning, shade, manuring, cover crops, selection and breeding of good types. A Coffee Planters' Union and a Coffee Consulting Committee have co-operated with the Department, and a Coffee Board with power to impose a levy to provide funds for promoting the welfare of the industry has recently been established.

The levy was put into operation from March 1933 at the rate of 50 cents (*6d.*) per cwt. of clean coffee. The primary functions of the Board are stated to be the investigation and organisation of markets, the reduction of marketing costs, and the assuring that the crop is disposed of to the best advantage.

Since 1927 occasional Coffee Conferences, or Coffee Planters' Days, have been held by the Department for the discussion of important questions.

The cultivation of Robusta has been considered, e.g. in 1926, but it was not deemed expedient to introduce this species into the Arabica area. Trials are, however, being made with Robusta and also with Liberica on the coast.

As the outcome of a recent decision of the Secretary of State for the Colonies that an experiment should be made with a scheme of native coffee production in Kenya, the Coffee Board has recommended the advisability of ensuring strict control over native planting and its confinement to districts at a distance from European plantations.

Recently an investigation has been initiated into the factors influencing the liquoring quality of coffee. The proposal was put forward by the Coffee Planters' Union and has been undertaken by the East African Agricultural Research Station at Amani in co-operation with the Imperial Institute.

Uganda

Uganda ranks fifth amongst the coffee-producing countries of the Empire with an average export of about 2,500 tons. The industry started, and for some years was developed, as a European (or non-native) cultivation of Arabica : in 1908 the exports were a little below 10 tons.

Later the natives took up the cultivation of the indigenous Robusta. Robusta has, in addition, been largely substituted for Arabica in the lower-lying non-native plantations, whilst Arabica is also cultivated by natives in suitable areas.

The position in 1931 was as under:

	Non-Native.	Native.	Total.
	Acres.	*Acres.*	*Acres.*
Arabica	10,837	7,498	18,335
Robusta	6,722	14,157	20,879
Total . . .	17,559	21,655	39,214

The measures which have been successfully adopted to develop the industry are of interest.

Arabica.—Introductions were made about 1900 from Nyasaland and Tanganyika (then German East Africa). The former variety was called "Nyasa" or "Nyasaland" and the latter "Bourbon" it having reached Tanganyika *via* the Isle of Bourbon apparently from Aden. A "Guatemala" variety was also introduced but differs very little, if at all, from the "Bourbon." The development of the industry has been hampered at times by labour difficulties, and also, when rubber has been more profitable, by the coffee being treated merely as a catch crop. In 1921 the advice of a visiting Coffee Expert was obtained and two years later a Coffee Officer added to the staff of the Department of Agriculture. By this time Arabica was failing in many localities and in 1924 the Coffee Officer advised that whilst the highlands were ideal for Arabica, in the lower and more humid districts only areas with a rich fertile soil were suitable. A year later he definitely recommended that below 4,500 ft. was not suited to Arabica, and in such areas selected types of Robusta are now largely grown.

The policy of the Department has been to confine native cultivation to Robusta except in certain districts, e.g. the Bugishu country of Mt. Elgon and the Ankole district of the Western Province. In the Bugishu district during the last twelve years much practical assistance has been devoted to fostering the industry. Nurseries, both central and local, for the supply of plants have been established.

In 1922 a station was opened for pulping coffee received in the cherry, the growers taking back the wet parchment coffee to their own homes for further treatment. Other pulping stations have since been added. This system was not very satisfactory and resulted in parchment coffee of very irregular grade being marketed. In 1931 a further advance was made by the erection of a Native Administration Central Coffee Factory complete with facilities for artificial drying, hulling and grading of the coffee and the establishment at various centres of pulping stations equipped for wet pulping, fermenting and partial drying of coffee prior to its being sent to the Central Factory. The means are thus now available for native-grown Arabica to receive as good preparation as on an ordinary plantation.

To secure other improvements in Uganda coffee there was passed, as No. 26 of 1930, " An Ordinance to provide for the Grading of Coffee for Export." This ordinance has one interesting feature in that it does away with the necessity for, and cost of, a large staff of official inspectors or graders by enacting that in addition to officers of the Department of Agriculture, the managers of coffee estate factories can give export certificates, for example for their own coffee. Safeguards are provided against the misuse of such power.

Robusta.—Robusta coffee is indigenous to Western Uganda and was grown by the natives long before the advent of Europeans. Speke, in his *Diary of the Discovery of the Source of the Nile* written in 1863, mentions receiving in the region near the southern end of Lake Victoria Nyanza presents of a coffee " which grows in great profusion all over this land in large bushy trees, the berries sticking on the branches like clusters of holly berries." The natives continued to grow Robusta in a casual manner, and serious work by the Department of Agriculture in developing an industry in this species dates from 1916. A wide range of varieties was grown and their produce forwarded to the Imperial Institute for liquoring tests and ascertainment of their market value. Some were poor but one sample sent in 1918 was so satisfactory that the Imperial Institute reported that the experts to whom it had been submitted had suggested " it would be desirable

to use this seed for propagation in Uganda." This was done, Mr. T. D. Maitland the Government Botanist stating in 1926 that "we have stuck to this type ever since." Plants were distributed from central and subsidiary nurseries established in many localities and instruction given both orally and by literature in English and the vernacular.

The native methods of cultivation and propagation were gradually improved, and, as already mentioned, Robusta was also grown on an increasing scale on the non-native plantations at lower elevations which had proved unsuitable for Arabica. The Department of Agriculture has continued the selection and distribution of the best types for both plantation and native cultivation, and by 1931 Robusta accounted for a little over one-half of the total area under coffee in the Protectorate.

Tanganyika

In Tanganyika both Arabica and Robusta coffee are grown, and there are non-native and native cultivations. The general conditions of the industry thus resemble those of Uganda in distinction to Kenya.

Robusta coffee is indigenous in the North-West district bordering on Uganda and the Belgian Congo, whilst Arabica has been introduced. It will be convenient to deal separately with the development of the two species.

Arabica.—The first variety, introduced in 1893, was the "Bourbon" which a few years later was taken to Uganda and Kenya, and is still one of the principal coffees of these three countries. Subsequently other varieties have been received, e.g. "Kent" and "Jackson," from South India.

The early plantings were made in the Moshi district on the slopes of Mt. Kilimanjaro and the Arusha district on the slopes of Mt. Meru. These districts and the Usambaras, all close to the Kenya boundary, are now the chief Arabica-producing areas, the amount of Robusta in them being negligible.

The best altitude is between 4,500–6,000 ft. The "Bourbon" is the chief strain, with "Kent," which is

more resistant to *Hemileia* disease, at the lower elevations. Arabica can be grown below 4,500 feet but requires more shade and is more subject to diseases and pests.

In 1932 the quantities of parchment coffee produced for export by the three districts were: Moshi 2,539, Arusha 1,329 and Usumbaras 239 tons.

Of the total, non-native or estate cultivation accounted for 3,015 tons, whilst of the 1,092 tons produced by natives no less than 1,033 tons came from the Moshi district on Mt. Kilimanjaro. It is reported that much of the coffee bears alternate good and poor crops as illustrated by the following average yields of parchment coffee per 100 acres of six estates taken at random: 1929, 5 tons; 1930, 27 tons; 1931, 3 tons; 1932, 21 tons. This is attributed to wrong practices, e.g. deep planting, excessive cutting of roots, omission to clean-weed before planting, soil erosion, excessive irrigation and drastic pruning. The Department of Agriculture has recently urged that unless the facts are faced, gradual replantings made with care to prevent soil erosion and past cultural errors avoided, the outlook is gloomy in spite of local conditions being excellent. It is encouraging that steps are being taken to effect improvements. There are Planters' Associations, and a Coffee Advisory Board comprised of unofficial and official members, to further the welfare of the industry. A Coffee Experiment Station has recently been established on Kilimanjaro.

Amongst the native growers the most progress has been made in the Mt. Kilimanjaro area where there are about 12,500 small cultivators. Here a Native Coffee Planters' Association, formed some eight years ago, has developed into a corporate body, with sixteen sub-societies, called the Kilimanjaro Native Co-operative Union, Ltd., with a European Manager. The Annual Report for 1932 of the Department gives particulars of the activities of the Association and says " their present methods of marketing, and their increased equipment and stock of chemicals [for spraying], together with better efficiency of the native staff and the closer co-operation which exists with the departmental staff, leave a sense of security which has not been the case before. The team work . . . . is a

good augury for future all-round improvement in culture, pest control, preparation, yields and quality of native coffee."

Robusta.—The main production of this species is in the Bukoba District of the Lake Province. Arabica is also grown here, the export figures for 1932 being 1,401 tons of Arabica and 5,705 of Robusta. Efforts are being made to concentrate attention on Robusta as being more suitable. The industry is still in a primitive stage and it was reported in 1931 that the output could be practically doubled did native owners regard the crop as something other than a " wild culture." The quality of the produce has declined for some years but the Department was able to state in 1932 that " by the application of inspection, much of what passed as coffee in earlier years does not now leave the port." All possible effort is being made by the Department to improve conditions and to foster the spirit of co-operation which has been so successful in, for example, the Kilimanjaro area.

Nyasaland

Nyasaland was the scene of the first European efforts to grow coffee in British tropical East Africa. Arabica was introduced into the Protectorate (then British Central Africa) in 1878 when one plant, out of three supplied by the Royal Botanic Garden, Edinburgh, was established in the garden of the Blantyre Mission. The seeds borne by this plant were used to start coffee cultivation in the Mlanje and Shire Highlands, and later descendants grown in Kenya and Uganda became known as " Nyasa " or " Nyasaland " coffee.

The variety of coffee introduced is sometimes stated to have been a Jamaica " Blue Mountain " type, but in answer to recent enquiry Sir W. Smith, Regius Keeper of the Royal Botanic Garden, Edinburgh, reports that no record can be found there of the variety supplied to the Blantyre Mission in 1878.

The industry flourished for some thirty years, the exports reaching a maximum of about 800 tons. Then a decline set in, attributed to failure to maintain soil fertility, including prevention of erosion, and to the fall in the price

of coffee. In 1927 the exports were as low as 16 tons. Since then they have risen again to some 60 tons, and it is considered that " there remains the prospect of a small and sound industry in European hands, provided that due attention is given to shade, conservation of soil, and methods of cultivation which will assist the coffee to withstand the long, dry period of the year."

Sierra Leone

Stenophylla coffee is native to and thrives in the highlands of Sierra Leone, whilst the introduced Liberica, Robusta and Canephora are more suited to lower elevations. During the last thirty years the exports have ranged from one to ten tons a year. In 1928 and 1929 the natives became keen on planting coffee and the Department of Agriculture gave assistance by again distributing seed, establishing nurseries, etc. Recent experimental work has led to the decision to encourage Robusta as the most generally suitable type for commercial production.

Gold Coast

At the beginning of this century the Gold Coast exported over 20 tons of coffee per annum. A rapid fall in production followed and the exports are now very small, whilst imports have increased. An attempt to encourage the industry by giving bonuses, £5 for the first year, less in the second and third years, to selected plots of one acre, was initiated in 1923.

To obtain information, experiment plots were established from 1908 onwards at each of the Department's seven experiment stations, of Liberica, Robusta, Stenophylla and Arabica. The results to 1927, summarised in the *Year Book* of the Department of Agriculture for 1928, show that Arabica gave consistently very poor returns. The comparative yields of clean coffee per acre for the other species in full bearing at the five best stations were approximately: Liberica, 4 cwts.; Robusta, 3 cwts.; and Stenophylla, 2 cwts.

Robusta has the advantage over Liberica in that the coffee is of better quality and flavour, and also that 4·6 lb.

of Robusta cherries yield 1 lb. of clean coffee as against 9·7 in the case of Liberica: this is an important point where transport of the cherries to the pulping station is a large item in harvesting costs. The production of coffee, if only for local consumption, is regarded as worthy of more attention.

NIGERIA

After the collapse of the coffee industry of Ceylon considerable efforts were made to develop coffee cultivation in West Africa, as for example at Lagos and in Southern Nigeria. Liberica was principally grown and assistance was given by Kew through the Botanic Stations of those days.

In 1901 the exports from Nigeria were nearly 30 tons, but by 1932 they had dwindled to 7 cwts. Liberica is still mainly grown, chiefly, however, for local consumption which tends to increase. A beginning has recently been made of establishing experimental plots of other varieties, e.g. types of Robusta.

UNION OF SOUTH AFRICA

A moderate Arabica coffee industry formerly existed in Natal, but it has largely succumbed to attacks of *Hemileia* disease. Experiments were initiated in 1927 to test the possibilities of this crop, with the advantage of modern knowledge, in Natal and the Northern Transvaal.

The Union at present imports coffee, mostly from Brazil, to the value of some £500,000.

NORTHERN RHODESIA

Coffee after being grown casually in Northern Rhodesia for some years was taken up on a commercial scale chiefly in the Abercorn district, with seed of a "Blue Mountain" type from Jamaica. The early results were very promising but the life of the plants has been very short, owing largely to unfavourable conditions and treatment. The rainfall is low, about 40 inches, and badly distributed, the dry season lasting some six months; high winds are prevalent; soil erosion is a serious problem and the white borer (*Anthores*

leuconotus) is a major pest. Irrigation is now practised and plantings have recently been made. During 1930–31 the area under coffee rose suddenly from about 150 to close on 500 acres. The exports in 1930–31 were 156 cwts. and in the following year only 29 cwts. Some of the new plantings under more favourable conditions will, it is hoped, give better results. The industry is admittedly still experimental. Excelsa might be worth trying here and also in Southern Rhodesia.

Southern Rhodesia

During the four years ended in 1931–32 the area under coffee increased from 37 to 100 acres and the exports from 4 to 59 cwts. Coffee had been grown previously but had almost all died out, owing to unfavourable conditions, poor treatment and attacks of *Hemileia* disease. During the last fifteen years the Department of Agriculture has supplied seed free, and reports that, whilst many recipients either failed to carry out instructions or allowed the plants to die for want of attention, in a few cases very promising results have been obtained. Arabica varieties, "Bourbon" and "Jackson," are now being distributed and it is considered that with proper care coffee may become an important crop on the eastern border.

Australia (Queensland)

In Australia the commercial cultivation of coffee has been practically limited to Queensland. Towards the close of the last century the prospects appeared favourable and cultivation was extended to reach its maximum of about 550 acres and a production of a little under 60 tons in 1901. Both Arabica and Liberica were grown. Since then there has been a decline, and in 1932 the area under coffee was only 17 acres and the production less than 4 tons, whilst the imports are about 1,600 tons, about one-half coming from the Netherland East Indies.

Territory of New Guinea

Whilst coffee was introduced several years ago it has not yet become a commercial crop. On account of the favourable results of some small-scale experiments, the

Department of Agriculture suggested in 1931 that coffee might be worth growing in view of the tariff preference offered by Australia.

Jamaica "Blue Mountain" is bearing well at 3,500 feet, but although ample land is available up to 4,500 feet developments must await road construction. On the easily accessible lower levels Arabica is not recommended, owing to liability to *Hemileia*, but good types of Robusta have been introduced, borne heavily, and realised good prices in Sydney.

Fiji

Coffee was formerly an important industry in Fiji until most of the bushes were destroyed by coffee leaf disease. The Department of Agriculture stated in 1922 that both Arabica and Liberica had done well for many years at the Nasinu Experiment Station and suggested that coffee might be profitable as a subsidiary crop.

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GRADING RULES AND STANDARD SIZES FOR EMPIRE HARDWOODS INTENDED FOR SHIPMENT TO THE UNITED KINGDOM

Report by Imperial Institute Advisory Committee on Timbers

For some years past it has been recognised that the developing trade in the newer hardwoods exported from overseas Empire countries to the United Kingdom has been hampered by difficulties met with by shippers arising from the lack of recognised grading rules acceptable alike to exporters and the trade in this country, as well as from the wide range of sizes of sawn material current in the home market. As a result of a letter to the press on the subject from Mr. W. A. Robertson, formerly Conservator, Forest Utilisation Circle, Rangoon (now Director, Forest Products Research Laboratory, Princes Risborough), the Imperial Institute Advisory Committee on Timbers appointed a representative Sub-Committee to consider the general question and to prepare grading rules for square-edged Empire hardwoods intended for shipment to the United Kingdom and also a schedule of sizes of sawn material adequate for the average needs of the market.

A report by the Sub-Committee comprising recommendations under both these heads has been adopted by the Advisory Committee and the Grading Rules proposed have been accepted for the trade in this country by the Hardwood Section of the Timber Trade Federation of the United Kingdom. The report has also been despatched to overseas countries concerned, with a view to the use of the rules in dealing with future shipments.

Experience gained in working with the rules will enable necessary modifications to be made and an agreement reached as to final grading rules subject to amendment as new circumstances arise. The British Standards Institution have agreed to the circulation of the rules with the object of considering them in due course for inclusion in the National Specifications for Timber which that body has in preparation.

The report of the Committee, containing the Grading Rules and Standard Sizes, is as follows :

Introduction

In the course of their work regarding the development of the use of Empire timbers in this country, the Imperial Institute Advisory Committee on Timbers have recognised that hitherto the marketing of overseas timbers (more particularly hardwoods) not yet fully established in commerce has been hindered by the absence of clearly defined grading rules accepted by the trade, and the large number of dimensions in which producers may be asked to supply the timbers.

A letter on the subject from Mr. W. A. Robertson, formerly Conservator, Forest Utilisation Circle, Rangoon, calling attention to the difficulties encountered in this connection by timber producers in the tropics, appeared in *The Times* of September 12, 1932.

The Advisory Committee thereupon discussed the question with Mr. Robertson, and a Sub-Committee, on which Mr. Robertson consented to serve, was appointed to enquire into the subject and to prepare standard grading rules and schedules of sizes for overseas Empire hardwoods. Mr. J. P. Fraser acted as Chairman of the Sub-Committee, which comprised members representative of overseas producers, and of the trade and timber-using industries in this country. The Sub-Committee had power to co-opt additional members.

After the appointment of the Sub-Committee it was learnt from the report of the Imperial Economic Conference, Ottawa, 1932, that the Conference had recommended that in regard to timber (among other commodities) steps should be taken in those parts of the Commonwealth concerned " to secure a greater degree of uniformity in standard specifications and trade practices." The British Standards Institution, as the national standardising body in Great Britain, thereupon undertook to prepare for this country national standard specifications for timber and set up a Technical Committee for the purpose.

The British Standards Institution was informed of the action already taken by the Imperial Institute Advisory Committee on Timbers, and its Sub-Committee, in regard to preparing grading rules and schedules of sizes for Empire

hardwoods, and it was arranged that the rules and schedules recommended by the Sub-Committee, after approval by the Advisory Committee, should be transmitted to the British Standards Institution for consideration as the accepted grading rules and schedules of sizes for overseas Empire hardwoods (square-edged) for inclusion in the National Specifications for Timber of Great Britain.

Co-operation between the British Standards Institution and the Imperial Institute Timbers Committee was secured by the appointment of members of the Imperial Institute Committee to the British Standards Institution Committee (and its drafting Sub-Committee) set up to consider national specifications for timber, and Mr. C. J. Chaplin, Chairman of the drafting Sub-Committee, was appointed to the Imperial Institute Sub-Committee.

The report of the Imperial Institute Sub-Committee, which comprises recommendations as to Grading Rules and a Memorandum on Sizes, has been approved by the Advisory Committee and forms the subject of this publication. The Report contains a recommendation regarding enquiries considered necessary for obtaining further information as to the percentages of timber conforming to the respective grades obtainable from logs of the different timbers (see p. 540, para. 5). Preliminary action has been taken in regard to this recommendation.

The Report has been submitted to the Hardwood Section of the Timber Trade Federation of the United Kingdom, who have approved the Grading Rules and Sizes for commercial use in this country.

The Report has also been submitted to the British Standards Institution, who have arranged to circulate it among their correspondents for observations. Pending the receipt and consideration of such comments the British Standards Institutions have not yet finally accepted the detailed Grading Rules but have agreed that the Rules and Schedule of Sizes should be put into trial operation forthwith with a view to testing their practical utility.

It is therefore recommended that the Grading Rules here put forward should be used in commerce from now onwards until the final National Specifications become available. Experience of the practical suitability of the Rules will thus

be obtained and opportunity afforded to effect such amendments as appear necessary before incorporation in the national specifications. Observations in this connection are specially desired from Forestry Departments, central standardising bodies, shippers, merchants, users and other interests concerned. All communications on the subject should be addressed to the Director, Imperial Institute, London, S.W.7.

October, 1933.

IMPERIAL INSTITUTE ADVISORY COMMITTEE ON TIMBERS

REPORT OF THE SUB-COMMITTEE ON STANDARD GRADES AND SIZES (SQUARE-EDGED HARDWOODS)

Grading Rules and Standard Sizes for Empire Hardwoods (Square-edged) Intended for Shipment to the United Kingdom

The Sub-Committee appointed by the Imperial Institute Advisory Committee on Timbers to consider the question of preparing standard grading rules and schedules of sizes for Empire hardwoods have completed their enquiries and now submit their Report.

2. At an early stage of their work the Sub-Committee recognised the importance of obtaining as full information as possible regarding the views of overseas producers. They therefore exercised their power of co-opting additional members and selected gentlemen from among forestry officers at home on leave and other overseas official representatives in this country. It was also considered important that the Sub-Committee's recommendations should be based on principles similar to those adopted by the Sub-Committee of the British Standards Institution considering the grading of softwoods. An invitation, which was accepted, was therefore extended to the Chairman of that body to join the Sub-Committee. The final constitution of the Sub-Committee was as follows :

JAMES P. FRASER, F.R.G.S., Messrs. James P. Fraser & Co. (*Chairman*). (*Formerly Chairman of the Hardwood Section of the Timber Trade Federation of the United Kingdom.*)

J. B. AITKEN, B.Sc., Assistant Conservator of Forests, British Guiana.

A. H. BARNES, F.R.I.B.A.

P. J. Birch, Messrs. Wm. Birch, Ltd. (*Past President of the High Wycombe and District Furniture Trade Federation.*)

G. F. Cameron, Assistant Conservator of Forests, Nigeria.

C. J. Chaplin, M.Sc., M.E.I.C., Chairman, Timber Technical Sub-Committee (Softwoods) of the British Standards Institution.

Major J. R. Cosgrove, D.S.O., M.C., Utilisation Officer, Forest Products Research Laboratory, Princes Risborough.

J. P. Edwards, Assistant Conservator of Forests, Straits Settlements and Federated Malay States.

A. R. Entrican, Engineer in Forest Products, New Zealand State Forest Service.

F. C. Faraker, Commercial Officer, Office of the Australian Minister, London.

Lt.-Gen. Sir William T. Furse, K.C.B., D.S.O., Director, Imperial Institute.

E. Locks Latham, Messrs. James Latham, Ltd. (*Past President of the Timber Trade Federation of the United Kingdom, Chairman of the Hardwood Section of the Timber Trade Federation of the United Kingdom.*)

J. N. Oliphant, B.A., M.B.E., Deputy Director of Forestry, Straits Settlements and Federated Malay States.

Lt.-Col. Sir David Prain, C.M.G., C.I.E., F.R.S., Chairman, Advisory Council on Plant and Animal Products, Imperial Institute.

W. A. Robertson, F.R.G.S., formerly Conservator, Forest Utilisation Circle, Rangoon.

L. C. Rowney, Assistant Conservator of Forests, Gold Coast.

F. T. Sandford, Secretary, Office of the High Commissioner for New Zealand, London.

H. D. Searles-Wood, F.R.I.B.A., Chairman, Imperial Institute Advisory Committee on Timbers ; Chairman, Technical Committee on Timber of the British Standards Institution.

HARRISON WATSON, Chief Canadian Trade Commissioner in the United Kingdom.

Sir HUGH WATSON, Timber Adviser to the High Commissioner for India.

Dr. S. E. CHANDLER, Imperial Institute (*Secretary*).

Mr. K. G. FENSOM, Managing Director, Canadian Hardwood Bureau, Ottawa, was present at meetings by invitation.

3. The Sub-Committee decided that their enquiries should be confined to overseas Square-edged Hardwoods. Their recommendations in regard to this class of timbers comprise two documents, namely :

(1) Grading Rules for Empire Hardwoods (Square-edged) intended for shipment to the United Kingdom.

(2) A Memorandum on Sizes of Empire Hardwoods (Square-edged) intended for shipment to the United Kingdom.

The Sub-Committee recommend that these documents should be regarded as separate papers.

4. The Sub-Committee desire it to be understood that the Grading Rules and Memorandum on Sizes recommended by them will be subject to amendment from time to time as further experience is gained in regard to the milling capacities of Empire hardwood species and the uses of the timbers in industry ; as new timbers become available in commerce ; and in consequence of other factors.

They recommend, therefore, that the Grading Rules should be employed until such time as other final Rules based on full information regarding the milling capacities of the logs and requirements of consumers in this country are available. Further, in the Memorandum on Sizes, attention is drawn to the care which is essential in regard to the use of a schedule of sizes.

5. The Sub-Committee are impressed with the need for obtaining information necessary for the preparation of final Grading Rules for Empire hardwoods and submit the following recommendation to the Advisory Committee on Timbers for consideration as to suitable action :

That the Governments of the Dominions, India and Colonies concerned in the production of hardwoods for export should be asked to institute enquiries, including mill studies, with a view to ascertaining the percentages of material, conforming to the different grades, which are capable of being produced from average logs of the various species of timber exported from their respective countries.

JAMES P. FRASER (*Chairman*).

S. E. CHANDLER (*Secretary*).

September, 1933.

Appended :

GRADING RULES. MEMORANDUM ON SIZES.

GRADING RULES FOR EMPIRE HARDWOODS (SQUARE-EDGED)

A. HARDWOODS FROM COUNTRIES OTHER THAN CANADA AND NEW ZEALAND

I. Standard Grades

1. **First Quality or Prime.**—Boards and planks to be 6 in. and up wide, and 8 ft. and up long. They must be flat, well cut and full to thickness and have parallel edges. All pieces containing less than 8 ft. face measure must be free from defects. Pieces containing from 8 to 12 ft. face measure will admit one standard defect. Pieces containing from 12 to 16 ft. face measure will admit two standard defects, and over 16 ft. face measure three standard defects. At least x per cent. of the material as a whole must be free from defects ; the value of x for the principal timbers concerned is stated in Appendix II. A standard defect is one as defined in the attached Schedule (Appendix I).

2. **Second Quality.**—Boards and planks to be 4 in. and up wide, and 6 ft. and up long. They must be well cut, and full to thickness and have parallel edges except that not more than 5 per cent. of boards which show slight irregularities in sawing and which otherwise would be First Quality or Prime will be admitted. The variations in thickness must not exceed $\frac{1}{16}$ in. under or $\frac{1}{8}$ in. over the

contract thickness. Boards and planks of Second Quality must give not less than the following percentages of clear lumber :

Pieces from 2 to 4 ft. surface measure, 75 per cent. of clear lumber in one cutting.

Pieces from 5 to 7 ft. surface measure, 75 per cent. of clear lumber in two cuttings.

Pieces from 8 to 10 ft. surface measure, 75 per cent of clear lumber in three cuttings.

Pieces from 11 to 13 ft. surface measure, 75 per cent. of clear lumber in four cuttings.

Pieces with 14 ft. or over surface measure, 75 per cent. of clear lumber in five cuttings.

No cutting to be admitted which is less than 3 ft. long by 3 in. wide, or 2 ft. long by 4 in. wide.

II. Wormy Grades

1. **Prime Wormy.**—Boards and planks to be 6 in. and up wide, 6 ft. and up long, but not more than 20 per cent. of the number of the pieces to be less than 8 ft. long.

Splits not exceeding 6 in. in aggregate length will be admitted at one or both ends, but otherwise the boards or planks must be free from all defects except pin worm holes and shot worm holes.

Boards and planks of Prime Wormy Quality must give not less than the following percentages of clear lumber free from pin worm holes or shot worm holes :

Pieces containing less than 8 ft. surface measure, 75 per cent. of clear lumber in one cutting.

Pieces containing from 8 to under 12 ft. surface measure, 75 per cent. of clear lumber in two cuttings.

Pieces containing from 12 ft. and up surface measure, 75 per cent. of clear lumber in three cuttings.

No cutting to be admitted which is less than 3 ft. long by 3 in. wide, or 2 ft. long by 4 in. wide.

2. **Second Prime Wormy.**—Boards and planks to be 6 in. and up wide, 6 ft. and up long, but not more than 20 per cent. of the number of the pieces to be less than 8 ft. long. Splits not exceeding 6 in. in aggregate length will be admitted at one or both ends, but otherwise the boards or planks must be free from all defects except pin worm

holes and shot worm holes. Pin worm holes and shot worm holes are admitted without limit.

3. **No. 1 Common Wormy.**—To grade as in the standard grade of Second Quality except that pin worm holes and shot worm holes will be admitted without limit.

III. Grades for Shorts, Squares, Strips, Quarter-Sawn Stock

Shorts

First Quality or Prime Shorts to be free from all defects unless otherwise contracted for. The timber to be 6 in. and up wide, 3 ft. and up long, rising by half feet up to 6 ft.

Second Quality Shorts to be 4 inches and up wide, 3 ft. and up long, and to cut 75 per cent. clear in one cutting from pieces up to 4 ft. long. In pieces over 4 ft. long to cut 75 per cent. clear in two cuttings.

N.B.— Shorts should be measured and tallied as if four times the actual length. The resulting total divided by four gives the true contents of the parcel.

Squares

First Quality or Prime Squares must be free from all defects, except that, where squares are sold specifically for turning, slight defects on one or more corners which will turn off will be admitted. The specification of sizes will be as agreed between the parties to the contract.

Strips

First Quality or Prime Strips, unless otherwise agreed, must be free from all defects and straight. The specification of sizes will be as agreed between the parties to the contract.

Second Quality Strips must give 75 per cent. clear in two cuttings from all lengths under 12 ft. In lengths of 12 ft. and up, 75 per cent. clear in three cuttings.

N.B.—No cutting shall be considered which is less than 2 feet long.

Quarter-sawn Stock

The specifications of sizes and grades in quarter-sawn stock will be the same as in plain-sawn stock, with the following exceptions :

(*a*) **First Quality or Prime.**—In widths of 8 in. and up, 1 in. of bright sapwood will not be considered a defect. In widths under 8 in. no sapwood will be admitted.

N.B.—Any sapwood additional to that provided for above will be treated as a defect, each additional inch or less of bright sapwood being considered one defect.

(*b*) **Second Quality.**—In widths of 8 in. and up, $1\frac{1}{2}$ in. of bright sapwood will not be considered a defect.

N.B.—No sapwood additional to that admitted above will be considered as a usable timber.

B. Canadian Hardwoods

To be graded according to the Rules of the National Hardwood Lumber Association.

C. New Zealand Hardwoods

To be graded according to the Rules of the National Hardwood Lumber Association.

General Notes

1. Grading of rough lumber shall be done on the worse face, and of dressed lumber on the better face.

2. When defects or blemishes or combination thereof not described above (and not dealt with under Grading Rules) are encountered they will be considered as equivalent to known defects according to their damaging effect upon the piece under inspection.

3. Seasoning checks which are so serious in character as to damage the lumber shall not be admitted in the cuttings, but slight ordinary seasoning checks shall be admitted.

4. A pin worm hole is a worm hole not over $\frac{1}{16}$ in. diameter.

5. A shot worm hole is a worm hole over $\frac{1}{16}$ in. and not exceeding $\frac{1}{8}$ in. diameter.

6. A large worm hole is one over $\frac{1}{8}$ in. diameter.

7. When straight-grained timber is specified, the angle of grain shall not exceed 1 in 25.

8. The grading of dimension stock, e.g. flooring, must be the subject of special agreement between shipper and buyer.

9. The amount of sapwood in any board will be calculated on the average width of such sapwood throughout the length of the piece.

APPENDIX I

Schedule of Standard Defects

Definitions

Rule No.	Description.	Value.
1.	One knot ⅝ in. to 1¼ in. diameter or equivalent	= 1 defect
2.	One knot over 1¼ in. to 2½ in. diameter or equivalent . . .	= 2 defects
3.	One knot over 2½ in. to 3½ in. diameter or equivalent	= 3 defects
4.	Two knots under ⅝ in. diameter or equivalent	= 1 defect
5.	Three knots under ⅝ in. diameter or equivalent	= 2 defects
6.	One or more pin worm holes in group not exceeding 1¼ in. diameter .	= 1 defect
7.	One or more shot worm holes or equivalent in group not exceeding 1¼ in. diameter	= 1 defect
8.	One end split, or splits at each end, not exceeding in total length in inches the surface measure of the piece in square feet, each split opening out not more than 1 in. to the foot in length . . .	= 1 defect
9.	One end split, or splits at each end, not exceeding in total length in inches the surface measure of the piece in square feet, each split opening out more than 1 in. and under 2 in. per foot in length .	= 2 defects
10.	One inch or under of bright sap on one edge or its equivalent on both edges	= 1 defect

Each additional inch or part of an inch of bright sap shall be considered as equal to one defect.

Rule No.	Description.
11.	Half an inch of free side bend admitted in pieces 8 to 9 ft. long. Three-quarters of an inch of free side bend admitted in pieces 10 to 12 ft. long.
	One and a quarter inches of free side bend admitted in pieces 13 to 16 ft. long.
	Each additional half inch of side bend in all lengths shall be considered as equal to one defect.
	Not more than two defects allowed in any piece.

APPENDIX II

STATEMENT OF PERCENTAGES OF MATERIAL (SAWN LUMBER) OF SPECIFIED TIMBERS WHICH MUST BE FREE FROM DEFECTS IN ORDER THAT THE LUMBER MAY BE GRADED AS FIRST QUALITY OR PRIME

Abura (*Mitragyna stipulosa* Kuntze) .	60 per cent.
Australian Walnut (*Endiandra Palmerstonii* C. T. White)	80 ,,
Australian Blackwood (*Acacia melanoxylon* R.Br.)	80 ,,
Blackbean (*Castanospermum australe* A. Cunn.)	80 ,,
Borneo Camphor Wood (*Dryobalanops* spp.)	100 ,,
Borneo Teak (*Hopea* spp., *Shorea* spp. and *Isoptera* spp.)	100 ,,
Crabwood (*Carapa guianensis* Aubl.) .	60 ,,
Eng (*Dipterocarpus tuberculatus* Roxb.) .	90 ,,
Gurjun (*Dipterocarpus turbinatus* Gaertn. f.)	90 ,,
Haldu (*Adina cordifolia* Hook. f.) . .	75 ,,
Hora (Ceylon Gurjun) (*Dipterocarpus zeylanicus* Thev.)	80 ,,
Indian Silver Greywood (*Terminalia bialata* Wall.)	90 ,,
Indian White Mahogany (*Canarium euphyllum* Kurz)	75 ,,

Iroko (*Chlorophora excelsa* Benth. and Hook. f.)	60 per cent.
Jarrah (*Eucalyptus marginata* Sm.)	90 ,,
*Kapur (Malayan) (*Dryobalanops* spp.)	80 ,,
Karri (*Eucalyptus diversicolor* F. Muell.)	90 ,,
*Keruing (Malayan) (*Dipterocarpus cornutus* Dyer)	80 ,,
Keruing (Sarawak) (*Dipterocarpus* spp.)	80 ,,
Mahogany, African (*Khaya* spp.)	80 ,,
Mahogany, Honduras (*Swietenia macrophylla* King)	65 ,,
Meranti, red (*Shorea leprosula* Miq.)	25 ,, (tentative)
Mountain Ash (Victorian Oak) (*Eucalyptus regnans* F. Muell.)	90 per cent.
Nigerian Walnut (*Lovoa Klaineana* Pierre ex Sprague)	65 ,,
Obeche (*Triplochiton scleroxylon* K. Schum. and *T. nigericum* Sprague)	80 ,,
Padauk, Andaman (*Pterocarpus dalbergioides* Roxb.)	75 ,,
Padauk, Burma (*Pterocarpus macrocarpus* Kurz)	75 ,,
Pyinkado (*Xylia dolabriformis* Benth.)	75 ,,
Pyinma, Andaman (*Lagerstrœmia hypoleuca* Kurz)	75 ,,
Queensland Maple (*Flindersia Brayleyana* F. Muell.)	70 ,,
Seraya, red (*Shorea* spp.)	100 ,,
Seraya, white (*Parashorea* spp.)	100 ,,
Silky Oak (*Cardwellia sublimis* F. Muell.)	80 ,,
Tasmanian Myrtle (*Nothofagus Cunninghamii* Oerst.)	60 ,,
Tasmanian Oak (*Eucalyptus obliqua* L'Hérit.)	90 ,,
Thitka (or Burma mahogany) (*Pentace burmanica* Kurz)	90 ,,
White Bombway (*Terminalia procera* Roxb.)	75 ,,
White Chuglam (*Terminalia bialata* Wall.)	90 ,,

(Natural coloration admitted if no decay present.)

* All shipments of these timbers to be entirely free from sapwood.

APPENDIX III

Definitions of Technical Terms occurring in the Grading Rules

Blemish.—Of the same nature as a Defect (which see), but, considered by itself, so slight as to be negligible.

Board.—A board is a rectangular section cut from a log, square-edged, less than 2 in. in thickness and of equal thickness throughout its length.

Clear.—Free from all defects.

Cutting.—A rectangular section cut from a board or plank.

Defect.—Any flaw in timber tending to lower its economic value.

Dimension stock.—Timber cut to special sizes other than the usual widths, thicknesses and lengths.

Face measure and *surface measure.*—The area in square feet of one face of a board.

Free side bend.—Slight curve to one side in the same plane as the face of the board or plank.

Plank.—A plank is similar to a Board (which see), but 2 in. or over in thickness.

Quarter sawn.—Timber cut along, or in the general direction of, the rays.

Seasoning checks.—Hair cracks or slight partings of the fibres due to the shrinkage of the exposed surfaces during drying being more rapid than the shrinkage in the interior of the piece ; the checks to be of such a nature that they close up when drying is complete.

Shorts.—Short lengths of boards or planks not exceeding 6 ft. long.

Squares.—Squares are lengths of timber of square cross-section throughout.

Strips.—Narrow boards not over 5½ in. in width.

MEMORANDUM ON SIZES OF EMPIRE HARDWOODS (SQUARE-EDGED) INTENDED FOR SHIPMENT TO THE UNITED KINGDOM

The following is a list of sizes in common use in some of the timber-consuming industries in the British Isles. Other sizes are asked for from time to time, but those in the list are suitable for general requirements.

A very definite word of warning in regard to two points must be sent out with this list.

In parts of the Empire certain timbers have been found suitable locally for joinery work or for cabinet work, but it does not follow, by any means, that the same timbers will be acceptable for similar work in the British Isles. Other timbers from different parts of the Empire might conceivably be much more satisfactory in England by reason of their beauty, cost or reliability, and sawmill operators are therefore warned that there may be grave danger *in cutting quantities of their own timbers to these sizes without first testing the demands in the English market.*

The second point deals more particularly with the question of sizes in squares for chair legs, table legs and similar work. Owing to the stress of competition and financial stringency it is quite common to-day to use a square 1½ in. × 1½in. for the front leg of a chair where before the standard size was 2 in. × 2 in. Also, the fashion changes as to whether chairs are made with or without castors ; in the former case, naturally, a shorter square is required than in the latter case. Shippers are therefore warned that it would be dangerous to produce any large quantities of squares except against definite orders.

Joinery Work.—The best thicknesses for woods to be used in joinery work are 1¼ in., 1½ in. and 2 in. About 60 per cent. of the production should be in these sizes. Of the remainder about 15 per cent. should be in 1 in. thickness, 20 per cent. in 2½ in., 3 in. and 4 in., and about 5 per cent. in 5 in. and 6 in.

If a saw miller wishes to cut his wood into joinery sizes it will usually be necessary for him to cut a certain proportion into each of the above thicknesses.

For joinery work there is also a limited demand for long squares, i.e. principally 4 in. × 4 in., 5 in. × 5 in., from 8 to 16 ft. long.

Floorings.—The best sizes for hardwood floorings are :

1 in. × 4 in. and 1 in. × 4½ in.
1¼ in. × 4 in. and 1¼ in. × 4½ in.

In all sizes floorings should be cut full to thickness and full to width and free from sapwood.

Cabinet Work.—The usual thicknesses in cabinet work are ½ in., ⅝ in., ¾ in. and 1 in. By far the largest demand is for 1 in., with ⅞ in. at times used as a substitute for 1 in. in cheaper work. Thicknesses of ½ in. and ⅝ in. are used in considerable quantities for such work as drawer sides and wardrobe backs.

In the cabinet trade there is a limited demand for 1¼ in., 1½ in. and 2 in. thicknesses.

Cabinet Squares.—Subject to the variations in fashion the best sizes in short squares for chair-making, table legs and similar work are the following :

1½ in. × 1½ in. × 19 in., 24 in., 28 in., 30 in., 36 in., 42 in., 48 in., 54 in.
1¾ in. × 1¾ in. × 19 in. and 30 in.
2 in. × 2 in. × 19 in., 24 in., 28 in., 30 in., 36 in., 42 in., 48 in., 54 in.
2½ in. × 2½ in. × 10 in., 24 in., 28 in., 30 in., 36 in., 42 in., 48 in., 54 in.
3 in. × 3 in. × 19 in., 24 in., 28 in., 30 in., 36 in., 42 in., 48 in., 54 in.
3½ in. × 3½ in. × 19 in. 24 in., 28 in., 30 in., 36 in., 42 in., 48 in., 54 in.
4 in. × 4 in. × 19 in., 24 in., 28 in., 30 in., 36 in., 42 in., 48 in., 54 in. and 6 ft. and up.

NOTES

Preparation and Marketing of Papain.—At the present time almost the only country producing papain on a commercial scale is Ceylon. The tree (*Carica Papaya*) from which it is obtained grows well in many other parts of the tropics, and planters in East Africa, South Africa and other countries have under consideration the possibility of producing the material. Small supplies from East Africa have already reached the London market. The product is employed in medicine and in various digestive preparations.

In response to enquiries that have been received at the Imperial Institute for information on the preparation and marketing of papain the following notes have been compiled.

Tapping.—The papaw tree commonly begins to bear fruit when about a year old and remains fruitful for about 4 to 5 years. It is stated, however, that it is not profitable to retain the trees after the end of their third year.

Tapping should be done in the early morning and in Ceylon is always completed before 10 a.m. The fruits may be tapped every 4–5 days or at longer intervals until they cease to yield latex. Tapping is carried out by making longitudinal incisions ⅛ in. deep and about 1–2 in. apart in the rinds of the fully grown, but still green, fruits by means of a knife of bone, glass or sharp-edged bamboo. Steel should not be used as it discolours the latex. Subsequent tappings may be made in the rind between the previous incisions. The juice that exudes is collected in glass, porcelain or enamel vessels held beneath the fruit, and on exposure to air it quicky coagulates.

Yield.—The yield of papain varies very considerably according to the locality in which the trees are grown, the variety, and the amount of fruit per tree. In Ceylon 175 lb. of dried material per acre is regarded as a good yield, but the average yield per acre there is stated to be in the neighbourhood of 100 lb. per annum for the first year of tapping on flat lands and 80 lb. per annum on hilly or rocky lands. In the second year the yield is roughly one-half of that of the first year. About 4½ lb. of fresh latex are required to yield 1 lb. of dry papain.

Drying.—Drying should take place as soon as possible after collection, otherwise some putrefaction may occur accompanied by the production of a disagreeable odour. This may be obviated by adding a trace of formalin solution to the latex as it is collected. Time in drying may be saved by either squeezing the coagulated latex lightly in a cloth to remove some of the water or by pressing it through a colander or perforated plate.

Although drying should be effected without delay it should not be too rapid. Drying in the sun yields a dark-coloured product, and if this method is adopted care must be taken that the papain does not get too baked and its enzyme properties destroyed. The product is best spread on coarse linen stretched on frames and moved from time to time so that drying is as even as possible. At no time should the temperature exceed 100° F.

In places where the weather conditions are uncertain and drying takes place only slowly in the shade, or when large quantities of juice have to be dealt with, some form of drying apparatus is desirable. On large estates a hot-air chamber can be employed, but for the small producer a drying stove as used in Montserrat is more suitable. One form of such dryer consists of a chamber, 3 ft. high, 3 ft. wide, and 6 ft. long, the sides and ends of which are built of brick. About 1 ft. from the top the chamber is divided horizontally into two compartments

by a sheet of iron; beneath this, at one end, a small fire grate is constructed, whilst at the opposite end a chimney is built to lead the smoke from the lower compartment. In order to obtain an even heat in the upper compartment a layer of sand about 2 in. thick is spread on the iron sheet. The coagulated juice is spread on brown linen stretched upon frames which are made to fit the top of the dryer. The drying must be effected at a comparatively low temperature as otherwise the ferment is liable to be destroyed. As already stated the temperature should not exceed 100° F. Coconut shells or charcoal are used as fuel in this dryer and the operation of drying is completed in about six hours. It is stated that in this way a nearly white papain can be obtained.

Packing.—When quite dry, the papain should be roughly ground and is best packed in tins enclosed in wooden cases, each containing approximately 100 lb. The tin should be soldered so as to be quite air-tight, before the case is closed. The general style of package is similar to that employed for tea.

Grades.—There are two recognised grades of papain, the sun-dried and the oven-dried papain. The oven-dried is of a better colour and usually realises somewhat better prices. The principal factor, however, which determines the value of the product is the degree of enzyme (digestive) activity.

Prices.—The average pre-war price of Ceylon papain of good digestive power was 8*s.* per lb. The average prices during 1930, 1931 and 1932 were 7*s.*, 5*s.* 6*d.* and 5*s.* 3*d.*, respectively. In 1932 the price fell as low as 3*s.* 9*d.* per lb. but later recovered. The current price (December 1933) of average quality is 6*s.* 9*d.* per lb. Oven-dried papain usually commands a premium of 3*d.* to 6*d.* per lb. over sun-dried.

Trade.—Imports of the drug into the United Kingdom are not shown separately in the official trade returns. Shipments are, however, almost entirely from Ceylon. The exports from Ceylon in recent years, together with the countries of destination, are shown in the following table:

EXPORTS OF PAPAIN FROM CEYLON

To	1928. *lb.*	1929. *lb.*	1930. *lb.*	1931. *lb.*	1932. *lb.*
United Kingdom	11,054	9,265	12,927	14,596	16,022
France	2,753	1,069	4,141	2,056	1,555
Germany	—	908	867	415	512
Holland	—	10	—	—	—
United States	111,877	117,211	61,403	59,880	45,575
Belgium	—	—	—	—	680
Cochin China	—	—	—	—	12
Total	125,684	128,463	79,338	76,947	64,356

Literature.—The following publications deal with papaws and papain :

" The Papaya in Hawaii." *Bulletin No. 32 (1914), Hawaii Experiment Station.* (Washington, D.C. : Superintendent of Documents, Government Printing Office.)

Manual of Tropical and Sub-Tropical Fruits. (Chapter on " The Papaya and Its Relatives.") By W. Popenoe. (New York : The Macmillan Co. ; London : Macmillan & Co., Ltd., 1920, price 30s.)

" The Plant *Carica Papaya* and its Enzymes." *Agricultural Journal of India*, 1921, **16**, No. 5, 496–507. (Calcutta ; Government of India Central Publication Branch, price R. 1–8.)

" The Cultivation of Papaya and the Preparation of Papain." *Tropical Agriculturist*, 1927, **68**, No. 1, 3–8. (Colombo : Department of Agriculture, price 6*d*.)

" The Papaya." *Pamphlet No. 1 (1928), Pioneer Horticultural Institute, Secunderabad (Deccan), India.* (Obtainable from the Pioneer Horticultural Institute, price 6 annas.)

" Papaine." By H. W. Hofstede. *Mededeelingen van de Afdeeling Nijverheid No. 5 (1928), Department van Landbouw, Nijverheid en Handel, Ned. E. Ind.* (Seltevreden : Landsdrukkerij, price Fl. 7·25.)

" Papaya Culture." *Philippine Agricultural Review*, 1929, **22**, *No.* 2. (Manila : Bureau of Agriculture.)

" Production of Papain from the Fruit of the Papaya Tree (*Carica Papaya*)." *Agriculture and Livestock in India*, 1932, **2**, Pt. V, 471–489. (Calcutta : Government of India Central Publication Branch, price Rs. 2 or 3*s*. 6*d*.)

Imperial Institute Publications on Mineral Resources : *Gemstones.*—A new volume, entitled *Gemstones*, in the Imperial Institute series of mineral handbooks, was issued early in November by H.M. Stationery Office (137 pp., price 2*s*. 6*d*.). It covers the whole range of precious and semi-precious stones, dealing with the matter essentially from the economic standpoint, and in this respect differs from any work which has previously been published on the same subject.

The preliminary chapters, which occupy 31 pages, deal with the physical characters of stones, their value, means of identification and weighing. Each gemstone is described in some detail. Sections are devoted to modes of occurrence, cutting and polishing, artificial stones and imitations, marketing, prices and world's production. The tables of world production of diamonds by weight and by value, which cover the years 1913 and 1920 to 1932 and include all

the producing countries, afford a handy means of comparison of diamond output and value with world trade conditions, and bring out many interesting facts.

The main part of the book is devoted to a consideration of the occurrences of gemstones throughout the world, special consideration being given to the Empire countries.

The volume brings together in a handy form a mass of information on gemstones which hitherto could not have been obtained without much patient search through a very extensive and scattered literature. It should, therefore, be welcomed by all who are interested in this attractive subject, and especially by those directly concerned in the manufacture and sale of gemstones and jewellery products.

RECENT RESEARCH ON EMPIRE PRODUCTS

A Record of Work conducted by Government Technical Departments Overseas

AGRICULTURE

Soils and Manures

Ceylon.—The Officer-in-charge, School Farm and Experiment Station, Peradeniya, in his report for the period January 1 to June 30, 1933, states that the preliminary work to the commencement of a new soil-erosion experiment has been taken in hand. The complete results of the 1926 to 1932 experiments have already been reported (*The Tropical Agriculturist*, LXXX, **4**, pp. 190–207, April 1933). The objects of the new experiment will be to determine the amount of soil erosion, as previously, and, in addition, the amount of surface run-off under the different treatments. This has involved the roofing over of the pits, which has been completed ; and the making of all the pits entirely water-tight, so that no losses through leakage could occur. Attempts were at first made to render the pits impermeable to water by recementing them internally and treating the dry cement surface with applications of sodium silicofluoride solution. This proved successful for a time in the case of the pits in area A, but in the case of area B, in which leakages had commenced at a much earlier date, it did not have sufficiently accurate results. The only effective method has proved to be lining all the pits with galvanised sheeting. Separate galvanised tanks had to be made, therefore, to fit into

each pit and these perfectly cemented and fitted into place. This work has been steadily proceeded with and is nearing completion. It will add considerably to the value and accuracy of the results. Preliminary comparative tests will be made when the work is complete to see that each of the twelve tanks is in perfect order before the experiment is commenced.

The green-manure experiments started last year in collaboration with the Agricultural Chemist revealed losses of both nitrogen and carbon in all plots since the original sampling. If further experiments in this direction are undertaken, it has been decided that it will be necessary to take samples at the end of three- and six-month periods, and not after six- and twelve-month periods as was done before.

The Agricultural Chemist, in his report for the first half-year of 1933, also refers to these green-manuring experiments. He states that the two experiments carried out at the Experiment Station, Peradeniya, to determine the amounts of nitrogen fixed in the soil by the leguminous cover crop, *Calopogonium mucunoides*, and the effects of green manuring alone and in conjunction with artificial nitrogenous fertilisers have been completed and the results are being examined. A cursory examination of the data indicates that (1) under local climatic conditions the effects of green manures on the carbon and nitrogen contents of the soil are not apparent at the end of a period of six months, by which time the green manures appear to have entirely decomposed; (2) highest yields of dry matter and nitrogen in the crop are obtained from the plots manured with basic slag, the percentage of nitrogen being also highest in this case; (3) there is no appreciable difference between the dry matter yields of the crop from the cyanamide and untreated *Calopogonium* plots, but the percentage of nitrogen in the former is slightly higher; (4) there is a small increase in the nitrogen contents of the soil samples at the time of harvesting of the crop, but this increase is not maintained.

Insect Pests

Termites

Ceylon.—The following account of work carried out on termites, during the period January to June 1933, is contained in the report of the Entomological Division, Department of Agriculture.

The investigation of tea termites (*Calotermes* spp., etc.) pests has been continued. The study of the biology

of certain species of *Calotermes* is yielding interesting results. A colony of *Glyptotermes dilatatus* raised from neoteinic adults nearly 5½ years ago, and which produced winged adults towards the close of last year, has again yielded, during the period under review, a few winged adults. The *Neotermes militaris* colonies raised from winged pairs 6½ years ago are alive, and the older members of these colonies have developed small wing pads.

The Paris Green treatment of tea bushes infested with the various species of Calotermes has been continued with very satisfactory results, although certain estates have temporarily discontinued the treatment owing to the present need for reducing costs to a minimum. Recent figures received from an estate on which the treatment has been continued since 1928 indicate the cost of the treatment to be Rs. 1.10 per acre. This figure is based on the treatment of 8,000 bushes scattered over an area in which an average of 45 bushes per acre required treatment.

The investigations into damage caused to buildings by termites have also been continued. Two recent records of dry-wood-nesting termites causing injury to the roof-timbers of buildings at 4,200 and 4,300 ft., respectively, have been received. These insects are extremely common pests of building timber in all districts of the Island up to 3,500 ft. and, until recently, had not been found above this elevation.

Coptotermes ceylonicus, a common soil-nesting species at low altitudes, was found damaging bungalow timbers at an elevation of 4,200 ft., which is the highest altitude at which this species has been found in Ceylon. As this species is an extremely serious pest of low-country tea, this recent discovery of its existence in one of the most important of the up-country tea-growing areas is somewhat disturbing.

A paper on "Dry-wood-inhabiting termites as a possible factor in the etiology of sprue" has been published in the *Ceylon Journal of Science, Medical Section*, Vol. III, No. 1. This paper also records the results of investigations into the so-called "dry-rot" of timbers in Ceylon.

The study of the biology of dry-wood-nesting termites has been continued. A colony raised from winged adults of a species of *Planocryptotermes* about 5 years ago, gave rise to macropterous forms during the period under review. A colony of a species of *Cryptotermes*, now 4 years old, possesses nymphs with wing pads.

Tests with various building materials, especially of compressed fibre insulating fabrics, with regard to their resistance to termite attack, have indicated that, in many

cases, the claims made by the manufacturers as to their termite-resistant properties cannot be sustained.

Young *Grevillea robusta* plants were extensively damaged on one estate by *Coptotermes* sp., while *Neotermes greeni*, a common pest of this tree, has also been recorded.

Beverages

Cocoa

Ceylon.—The following account of work on cocoa is contained in the report of the Officer-in-charge, School Farm and Experiment Station, Peradeniya, for the period January to June 1933.

The 1932–33 crop year ended on March 31, and though the total wet yield was below the previous year's crop the out-turn of good cocoa showed a distinct improvement, being 51 per cent. compared with 36 per cent. last year. The total yield of dry cocoa per acre was thus 0·25 cwt. higher than the previous year. Next year's yields are likely to show a considerable setback as on account of the adverse weather this year between 3 and 4 per cent. of the total number of trees have died, and nearly an additional 1 per cent. have been damaged by the falling of the old "dadap" (*Erythrina lithosperma*) shade trees. The serious floods in May, when the greater part of the cattle-shed block and some of the centre block cocoa areas were up to 6 ft. under water continuously for three to four days, are responsible for some of the deaths, but by no means all. The removal and replacement of all the old dadap trees on the station, many of which are 25 or more years old, is being proceeded with as rapidly as possible. These are being replaced by *Derris robusta*, and about 250 of the latter have been put in up to date.

Apart from the setback caused by the weather the progress of the cocoa rejuvenation work is very satisfactory. In the hillside block the removal of all stems were completed and in the centre block the pollarded trees are making extremely good growth.

In connection with selection work it is stated that the multiplication of budwood is being proceeded with, but the weather has been against this work. The necessity for laying out new nurseries has been evident and the work is in progress.

Coffee

Ceylon.—The Officer-in-Charge, School Farm and Experiment Station, Peradeniya, in his report for the first half-year of 1933, states that selection work on

Robusta coffees has been continued and the figures will be examined at the end of the crop year (September 30). It appears probable that the number of selected trees, from which individual yield records are being taken, will have to be further reduced by the elimination of low or erratic bearers.

A preliminary small-scale cleft-grafting trial was commenced in April, using four-months-old well-grown seedlings of Excelsa (Liberian type) coffee as a stock. These seedlings were all the progeny of one selected tree. The scions used were sucker material of five selected trees of the Robusta variety, three selected Quillou and some unselected Hybrid variety material. The total of successes up to the middle of June was 13·7 per cent., most successes being obtained with the Quillou scions, 21 per cent.; one of which (KQ 2) gave nearly 37 per cent. successes. The unselected Hybrid material came next with 15 per cent., and the selected Robusta last, with only 4 per cent. These results will form the starting-point for more extended work in this direction as soon as sufficient nursery material from selected trees is available. The budding was all done in a nursery in the open and the weather was warm and dry for the week of budding, but subsequently turned much too wet for satisfactory results, just over 29 in. of rain being recorded for May.

Tea

Ceylon.—According to the report of the Officer-in-Charge, School Farm and Experiment Station, Peradeniya, for the half-year January to June 1933, the tea-pruning experiment, being run in collaboration with the Tea Research Institute, has been continued satisfactorily. The three methods of pruning being compared are clean pruning, rim-lung pruning and cut-across pruning. The records of wet and dry weight samples from the pluckings are recorded weekly. The results are forwarded to the Plant Physiologist of the Tea Research Institute where they are collated with the records of the other two experimental blocks at lower and higher elevations where similar experiments are being carried out. The manuring of the 18 blocks comprising the experiment was carried out early in January. The manure, a mixture of 320 lb. blood meal, 222 lb. superphosphate and 60 lb. muriate of potash, was applied to alternate rows at the rate of 56 lb. 5 oz. per plot of 250 bushes.

The Controller of Plant Pests reports that in connection with the control of shot-hole borer (*Xyleborus*

fornicatus) 175 permits were issued for the removal of 648,022 tea plants during the period January to June 1933.

With regard to tea tortrix (*Homona coffearia*), return post-cards were issued to 1,110 tea estates relative to the last quarter of 1932 and first quarter of 1933. The replies received have been analysed. It would appear from the information furnished by estates in regard to the numbers of Tortrix egg-masses collected that this compulsory measure has been of value in reducing the incidence of the pest.

Nine new estates in Uva have reported outbreaks of nettle grubs (*Limacodidæ*) since January.

Reference to work on tea termites is contained in the report of the Entomological Division on p. 555.

Cereals

Maize

Ceylon.—The Economic Botanist, Department of Agriculture, in his report for the period January to June 1933, states that selection work is proceeding in the varieties of dent maize introduced into Ceylon from Kenya. Selection is being made in the field for general vigour and in the laboratory for number of rows of grain in the cob. The crop promises to be a useful one for the drier areas of the island, and is definitely superior to the local variety.

Rice

Ceylon.--The following account of investigations on rice is contained in the report of the Economic Botanist, Department of Agriculture, for the period January to June 1933.

The pure-line selection of paddy varieties is being continued for such districts as are not yet supplied. Improvement by hybridisation is also receiving attention. Problems of immediate importance are being tackled by the hybridisation and subsequent selection of local pure lines and imported varieties which carry certain desirable characters lacking in the local varieties. In this way attempts are being made to introduce stiff straw and white testa, and a white testaed variety of a pure-line Mawi has been produced for the Central Division. It has been found by field trials, however, to be inferior in yield to the local parent, and attention is now directed towards the isolation of a high-yielding strain. At the same time that these particular experiments are in progress, a collection is being made of local varieties, of which there are thousands

in the island. Past selection work has been confined to the most widely grown varieties in any particular district and consequently only a small proportion of the varieties in existence have received attention. It is realised that probably every desirable character is to be found in one or other of the numerous varieties in Ceylon, and that were the characters of such varieties known it would be feasible to build up from them a superior type without having recourse to foreign varieties, which in most cases will not reproduce under our conditions the high yields obtained in their native habitat.

The progress of the attempts to select salt and flood-resistant forms is slow, but there are indications that a strain will be found to grow in brackish areas that have hitherto been uncultivable. Flood-resistant forms from India are being tried in the Colombo district, but plots of the same varieties grown for observation at Peradeniya were completely destroyed by the flooding of the Mahaweliganga which submerged the fields under 25 ft. of water for a week.

A series of experiments in paddy cultivation is being conducted in collaboration with the Agricultural Chemist. The experiments are designed to enquire into the reasons for increases in yield obtained from the application of manure and from various cultivation operations, and take the form of randomised replicated field trials combined with chemical analyses of crop and soil at regular intervals throughout the growing season. The first experiment of the series, the result of which will shortly be published in the *Tropical Agriculturist*, tested the results of the application of nitrogenous and phosphatic manures in various forms, and the preliminary results were reported in the half-yearly report of last year. The second experiment was started in the Maha 1932–33 season, and was a trial of transplanting versus broadcasting, and thinning versus broadcasting, with and without the application of ammonium phosphate at the rate of 96½ lb. per acre. The results indicate the superiority of transplanting and manuring, both separately and in combination, and give increases of 50 per cent. from transplanting, 30 per cent. from manuring, and 100 per cent. from a combination of the two processes. The observation of residual effects during the present Yala season has been destroyed by the flood previously mentioned, and when the chemical data have been analysed the complete results will be published. The third experiment will be started in the Maha 1933–34 season and will attempt to answer questions raised by the first experiment quoted above.

A further series of experiments has been started to test the relative economy of growing one crop or two crops per year on the same field. Preliminary trials have indicated that where one crop only is grown, with an intervening weed fallow, yields tend to increase, but that the increase does not compensate for the loss of the second crop. The scope of the experiment is now being widened to include not only a weed fallow, but also the growing of a green manure crop and of a money crop (such as vegetables) during the second season.

The Agricultural Chemist reports that the examination of the data of paddy manurial experiments carried out at Gampaha in the South-Western Division with different grades and quantities of Niciphos indicated that: (1) the $\left(\frac{22}{18}\right)$ grade of Niciphos was superior to the $\left(\frac{17}{48}\right)$ grade for the soil and climatic conditions of the district both from the point of view of yield and economic returns; (2) the quantity of Niciphos $\left(\frac{17}{45}\right)$ grade for optimum results appeared to be between 50 and 100 lb. per acre for the district.

He also states that the cause of the poor yields of paddy from a fairly large area at Vannivilankulam in the Northern Province was traced directly and indirectly to a high clay content of the soil.

The Acting Entomologist reports that the pests of paddy (*Oryza sativa*) recorded during the period were the paddy swarming caterpillar (*Spodoptera mauritia*), the stem-borer (*Schœnobius bipunctifer*), the locust (*Hieroglyphus banian*) and the leaf-hopper (*Sogota pallescens*), but the outstanding pest was the gall-fly (*Pachydiplosis oryzæ*) which is the causative agent of the "Silver shoot disease" of this crop. This pest is normally kept in check by its natural enemies, but the unusually wet weather experienced this year is considered to be a factor which has contributed to the exceptional prevalence of this insect. Parasites, not yet identified, have been bred from the material received.

Sorghum

Ceylon.—The Economic Botanist, in his report for the half-year January to June 1933, states that preliminary trials at Peradeniya indicated that *Sorghum margaritiferum* Stapf would grow successfully in Ceylon, but trials by field officers have not so far been successful; the failure is attributed to sowing at the wrong time as a result of a

failure to appreciate that the difference in the time required to reach maturity between this sorghum and the Indian ones previously grown demanded a difference in treatment. Experiments are now in progress to determine the best time for sowing.

FRUITS

General

Ceylon.—The following account of work on fruits is contained in the report of the Agricultural Chemist, Department of Agriculture, for the half-year January to June 1933.

Canning and Bottling.—Towards the end of the period, the bottling and hand canning outfits indented for the Chemical Division arrived. As it had been decided that work under this head be carried out by the division, a series of preliminary trials with the canning and bottling of mangoes and pineapples was started. The results up to now are very gratifying. The effect of the following factors on flavour and keeping quality are being or will be investigated: degree of maturity and condition of fruit, preliminary treatment of fruit, syruping, strength of syrup, time and temperature of sterilisation, technique of filling, exhausting and processing. Pineapples are much easier to can and bottle than mangoes, the flavour of the latter being very elusive and the fruit becoming soft on processing.

The Artificial Ripening of Fruits.—Carefully carried out quantitative experiments to determine whether ethylene gas had any effect on the ripening of oranges indicated that no appreciable changes in the composition of the fruit were brought about by the gas treatment. There was, however, a distinct fall in the total sugar content of treated fruit, due to increased respiration. The gas was found to have no effect on the colour of the local *Jaffna* mango, but the ripening was markedly hastened.

Cashew Nuts

Ceylon.—The report of the Agricultural Chemist, Department of Agriculture, for the half-year January to June 1933, states that in view of enquiries made by the Registrar-General about the " vitapack " process for preserving cashew nuts, a series of trials was started in bottles and tins to determine the keeping quality of cashew nuts under various conditions, viz. untreated, air-tight, in carbon dioxide-air mixtures and in carbon dioxide gas alone.

After a period of two months the treated samples were showing no signs of deterioration.

Citrus

Ceylon.—The report on the School Farm and Experiment Station, Peradeniya, for the half-year January to June 1933, contains the following account of work done on citrus.

The majority of the imported grapefruit trees have made good growth. Citrus canker is still a very serious trouble and regular weekly hand picking and burning of all canker-affected leaves and fruits has been rigorously prosecuted. It is considered that this has shown slightly improved results over spraying in the reduction of canker, and by the adoption of a combined hand picking and spraying programme it is considered possible to reduce the incidence of this disease very considerably provided outside sources of infection could be removed.

A more extended programme of selection work on citrus is in course of arrangement. This involves the preparation of a new and increased area for nursery selection work on stocks and the erection of a number of solar propagators for the purpose of raising vegetatively large quantities of scion material. This work has started, but was very seriously hampered by the serious flooding of large areas of the experiment station towards the end of May.

A case of fruit-fly attack was recorded in April, and in view of the serious damage this pest might have caused if any breeding and spread occurred, immediate precautions were taken to prevent this by stripping the trees of all fruit three-quarters ripe or over. This necessitated the removal of a considerable number of fruits, but the danger involved appeared to warrant such drastic measures being taken.

The Acting Curator of the Royal Botanic Gardens, Peradeniya, in his report for the period January to June 1933, also states that citrus canker is still, and has been, very troublesome during the period under review, and spraying to check this as much as possible has been regularly carried out. The special plots in the lower nursery in which experiments with various sprays were being carried out with a view to the control of canker and leaf-miner (*Phyllocnistis citrella*) were destroyed during the latter part of May by record floods and the plots were buried in sand and silt to a depth of 4 ft.

Early in February, 1,800 seeds of "wild grapefruit" were received from the Director of Agriculture, Trinidad

and Tobago, and were sown in the lower nursery. The seeds germinated well, but most of the seedlings were washed away by the floods.

As a result of the frequent dressings of sand and leaf-mould, the transplanting of budded plants from the nursery beds has been carried out more successfully, a more open soil resulting in a better root system.

Two budded plants of each of the following citrus have been procured from Australia and have been planted out : lemon, Villa Franca ; lime, West Indian and Tahitian ; mandarin, Emperor ; orange, Jaffa and Mediterranean Sweet.

With reference to the spraying experiments mentioned above, the Mycologist, in his report for the first half-year of 1933, states that the results up to the time of flooding indicated that the following combined insecticides and fungicides were capable of controlling the insect pests and fungus diseases of young citrus plants : Solol-Sulsol, Sulsol-Nicotine Sulphate and "Anti-Mildew" (Shell Coy.). Unfortunately statistical evidence of the improvement obtained by spraying was not obtained. That there was a considerable improvement in the plots sprayed with the three mixtures over the control unsprayed plots was indubitable.

The Acting Entomologist, in his corresponding report, also mentions that so far as the experiments progressed, all of the materials tested gave a satisfactory control of the leaf-miner. He adds that, included among the various pests of citrus recorded during the half-year was the scale, *Aspidiotus destructor*, on young lime (*Citrus medica* var. *acida*), which is a new host record in Ceylon.

According to the report of the Agricultural Chemist, a large number of bottles of sterilised lime juice was prepared and also of lime-juice cordial, after a satisfactory technique for small-scale work had been developed. Samples of the latter were reported on very favourably. Samples of citrate of lime were also prepared, but in view of the artificial synthesis of citric acid from sugar by-products, the manufacture locally of this product is not recommended.

Plantains

Ceylon.—The half-yearly report of the Controller of Plant Pests, Department of Agriculture, for January to June 1933, mentions that although bunchy top disease of plantains has been a declared disease under the Plant Protection Ordinance No. 10 of 1924, for many years, no

areas hitherto have been defined as infested nor have any regulations for the control of the disease been in force. During March, however, legislation was introduced to prohibit the movement of plants, or any parts of plants belonging to the genus *Musa*, into certain areas in the Southern Province where the disease does not occur. The areas infested by the disease were also defined. Reports of the presence of the disease have been received from most of the ranges in the island and it is reported to be particularly prevalent in the Kegalle area.

Stem and root weevils (*Odoiporus longicollis* and *Cosmopolites sordidus*) are reported from the Ratnapura and Polgahawela ranges only. The damage caused was not serious.

According to the report of the Mycologist, work has been continued on methods of eradicating plantain stools. In the second experiment, mentioned in the last report, different quantities of liquid fuel, applied after cutting down the clumps of plantains, were tested. Results were not entirely successful, but it was found that the growth of new suckers could be prevented by the application of 6–8 pints of common liquid fuel. The adoption of this method in small gardens may be recommended. Diseased plants should be cut down as nearly to ground level as is practicable and the oil applied on and around the suckers. As a control measure this would be too expensive for general adoption. A further experiment has been started with a more toxic oil which, although more expensive, promises to give cheaper eradication.

Further results have been obtained in the inoculation of plantains with *Fusarium cubense*. It has been shown that soil infection is sufficient for successful inoculation, although over a year may elapse between the date of inoculation and the appearance of the definite symptoms. Symptoms are always more marked in suckers developing subsequently to inoculation than in the parent inoculated plant.

Evidence has been obtained that a certain strain of *Fusarium cubense* causing Panama disease produces the disease in an acute form which is followed by the rapid death of the plant, while another strain gives rise to a chronic form of the disease which is not immediately fatal.

The strain of plantains most resistant to Panama disease appear to be Embun and Embul (the sour plantain). The former is listed as a susceptible variety in Malaya. A popular leaflet on the disease is in the course of preparation.

Spices

Ginger

Ceylon.—The following account of work carried out on ginger is contained in the report of the Agricultural Chemist for the half-year January to June 1933.

Ginger Curing Investigations.—About a ton of local ginger was cured by (1) the ordinary drying, (2) the sulphur curing method, and samples sent to the Imperial Institute for valuation and report. A full account of the work done on the subject and the results obtained has appeared in the *Tropical Agriculturist* of May 1933.

Ginger Manurial Trials.—The ginger manurial trials at Siyambalagoda were completed in January and the results examined statistically. Sulphate of potash and the mixed manure gave significantly higher yields than the controls, the superphosphate and nitrate of soda plots. The two latter treatments did not give significantly higher yields than the control. A full report of these experiments was published in the *Tropical Agriculturist* of May 1933. A comprehensive scheme of further manurial experiments has been started at Giragama, and is designed to test (1) the relative efficiencies of cattle manure and artificial fertilisers for ginger; (2) the effect of liming and a mulch of straw on crop yields; and (3) the interactions between the various factors contributing towards yield. Trials were also begun to determine (1) the optimum seed rate for ginger, (2) the best method of planting seed ginger.

Fodders

Grasses

Ceylon.—The Officer-in-Charge, School Farm and Experiment Station, Peradeniya, in his report for the half-year January to June 1933, states that, in collaboration with the Economic Botanist, work has been taken up for extensive trials of various grasses and other plants with the object of finding out and testing suitable mixtures for pasture purposes. In this connection a five-acre block, previously under old rubber, has been laid out in fifty one-tenth acre plots for the preliminary trials. Additional areas of the station previously uncultivated or under old rubber are in process of being cleared for establishing a series of intensive rotational grazing areas in connection with the work on the improvement of the local strain of black cattle. This work is as yet in its infancy, so it is too early to give any detailed report of value in this connection. An area under coconuts at the Bandaratenne end of the

station is similarly being taken in hand for a rotation of pasturage, fodder grass and green manure production.

In connection with the above investigations, one-twentieth of an acre plots of all the main fodder and pasture grasses are being established in the Panchikawatte area for the purpose of allowing them to run up for seed. The establishment of fodder grasses in Ceylon has in the past been done almost entirely by means of planting up root and stem cuttings. It is possible that birds and the climate at Peradeniya are adverse to good seeding, but the question is being investigated.

Oil Seeds

Coconuts

Ceylon.—The Controller of Plant Pests, Department of Agriculture, in his report for the period January to June 1933, states that black beetle (*Oryctes rhinoceros*) and red weevil (*Rhynchophorus ferrugineus*) have been reported from the various agricultural ranges of the Central, South-Western, North-Western, Eastern and Southern Divisions of the Island. No serious outbreaks have occurred. Coconut caterpillar (*Nephantis serinopa*) has been reported only from the Eastern Division and the attacks have not been of a serious nature. The few cases of bud-rot which have been reported have been suitably dealt with. Five records were from the North-Western Division and one from the South-Western Division.

Croton

Ceylon.—The Acting Entomologist, in his report for the first half-year of 1933, states that the life-history of the Croton Caterpillar (*Amyna punctum*) which, at certain seasons, defoliates Croton oil trees (*Croton Tiglium*) has been worked out. A single moth, which may live up to 26 days under laboratory conditions, lays from 500 to 980 eggs, the incubation period of which is 3 days. The larval period ranges from 11–14 days, and that of the pupa is the same. Oviposition commences from 3–4 days after development to the adult state.

Ground-nuts

Uganda.—The report on the work carried out at the Serere Plantation during the first half-year, 1933, states that the following trials with ground-nuts were commenced during the period.

1. *Spacing, Mulching and Variety Trial.*—An experi-

ment designed to ascertain the relative merits of mulching and clean weeding combined with the spacings 9 × 9 in., 1 × 1 ft. and 2 × 1 ft. of both the bunch and spreading varieties of ground-nuts. A lay-out of six randomised blocks was used, each block being divided in two sub-blocks of the two varieties and each sub-block being divided into six sub-plots of the six combinations of spacing, mulching and clean weeding. The experiment was planted in April. Rosette disease counts are being made periodically, the heaviest infection being in the widest spacing with no difference so far between mulching and clean weeding.

2. *Spacing Trial.*—An experiment designed to compare a still closer spacing with the standard, because previous trials have shown that the optimum spacing has not yet been determined. The spacings 6 × 6 in. and 1 ft. × 6 in. were used in a lay-out of a modified Half-drill Strip type giving five repetitions. The Bunch variety of ground-nuts was used and a duplicate experiment has been planted with the Spreading type.

3. *Method of Lifting Experiment.*—An experiment designed to compare costs and efficiency of various methods of lifting ground-nuts. The plot was divided into two halves and one half planted with the Bunch type, the other half with the Spreading type of ground-nuts. Three methods of planting were used, namely, at a spacing 1 ft. × 6 in. on the flat, two rows on 3-ft. ridges, the seed being sown 6 in. apart in the rows, and three rows on 3-ft. ridges, the seed being sown 6 in. apart in the rows. The ground-nuts will be lifted by hand, ridge plough, guntaka plough and a French Multicultur implement, and costs will be compared.

The experiments conducted at the Bukalasa Experiment Station during the period January–June 1933 were as follows :

1. *Rosette Disease Experiment.*—Lay-out, a 5 × 5 latin square with the following treatments :

A. Spacing 1 × 1 ft. clean weeded.
B. ,, 2 × 2 ft. clean weeded.
C. ,, 2 × 2 ft. clean weeded 6-in. round plants.
D. ,, 2 × 2 ft. mulched from germination with elephant grass
E. ,, 2 × 2 ft. mulched 2 months after germination, otherwise as in C.

The incidence of rosette disease as expressed as mean percentage of the stand infected was : A, 2·70 ; B, 6·38 ;

C, 5·24; D, 9·14; E, 3·5; S.E. of difference, 1·83. These results are significant in that treatment A results in less disease than treatments B and D. Treatment E less than D, and treatment C less than D.

The following table shows the yields obtained:

—	A.	B	C.	D.	E.	S.E.
Mean yield in lb. of five sub-plots	59·8	34·4	19·4	34·2	28·2	5·3
Percentage of mean	69·5	98·0	55·1	97·0	80·2	15·1
Lb. per acre	1,614	928	523	923	716	—

The conclusions that may be drawn are that A is better than all other treatments; B and D are better than C; E is provably better than C. Treatment C caused 43 per cent. loss in yield as compared with clean weeding. The spacing of 1 × 1 ft. gave 71 per cent. increase in yield over 2 × 2 ft.

2. *Ground-nut Spacing Experiment.*—Lay-out a 4 × 4 latin square; spacings, 1 ft. × 6 in., 1 × 1 ft., 1 × 1½ ft., 1 × 2 ft.; sub-plots, 64 × 90 ft. The mean yield of the four sub-plots were:

	lb.
1 × ½ ft	384·7
1 × 1 ft	345·0
1 × 1½ ft	315·2
1 × 2 ft	271·0

During the year, the following ground-nut varieties were tested against the Bukalasa variety. Yields of unshelled nuts per acre were as under:

	lb.
Virginia bunch	3,139
Philippine pink	3,458
Basse	1,820
H G 1	1,888
Bukalasa bunch	2,382

3. *Ground-nut Ridging Experiment.*—As in previous years it was found that no increase in yield is obtained from ridging, as compared with planting on the flat.

Tung Oil

Ceylon.—The Officer-in-Charge, School Farm and Experiment Station, Peradeniya, in his report for the half-year January to June 1933, states that the growth of the *Aleurites montana* plants in the Terraced Valley is extremely variable. Some plants, the oldest of which have now been planted out three years, have made good growth

and flowered for the first time this year ; others are very slow and have made only poor growth. Good growth is noticeable particularly on those terraces where the drainage is good and the plants sheltered from wind. The one old tree is in flower and has commenced to form fruit.

Essential Oils

Geranium Oil

Ceylon.—According to the Agricultural Chemist, at two different periods during the half-year January to June 1933, leaf material of scented geranium (*Pelargonium* sp.) from Hakgala at the stages of initial and full flowering, respectively, was steam-distilled. The average oil yield percentage obtained was 0·13. This compares very favourably with those obtained in other countries producing geranium oil. The total yield of oil obtainable per acre appears to point to the possibility of a small industry in the product. Samples of the oil were sent to England for report.

Lime Oil

Ceylon.—The Agricultural Chemist reports that the investigations on the extraction of lime oil (écuelled and distilled) from local limes were completed during the period January to June 1933. The yield of écuelled oil was only about half that obtained in the West Indies. The report of the Imperial Institute on the samples sent is awaited. The investigations, however, prove that the preparation of lime oil locally is not commercially feasible.

Ocimum Oil

Ceylon.—The report of the Agricultural Chemist for the half-year January to June 1933 states that the experimental distillation of samples of leaf and flower material of *Ocimum gratissimum* and *O. americanum*, two weeds with characteristic odours commonly found in the district, showed that there was no hope whatever of these products being utilised commercially. Hardly any oil was obtained with the former and only small amounts with the latter. The chemistry of these oils has been previously studied and their constituents found to be such as are more easily and cheaply available from other sources.

Fibres

Cotton

Uganda.—According to a report on the experimental work carried out at the Serere Plantation during the half-

year January to June 1933, a spacing and seed-rate trial planted in 1932 was harvested during the period under review. The experiment was designed to determine the better spacing of 4 × 1½ ft. and 3 × 1 ft. in June and July sowings, and also to determine the number of seeds per hole, 3, 6, 9 or 12, required to give the best stand and yield.

The conclusions drawn from this experiment were that :

(*a*) The stand from the July sowings was significantly better than that from the June sowing.

(*b*) There was no significant difference between the 4 × 1½ ft. and 3 × 1 ft. spacings.

(*c*) 9 and 12 seeds per hole gave similar stands ; both being significantly better than 6 seeds per hole ; the latter being significantly better than 3 seeds per hole.

(*d*) The interaction between seed rate and sowing date is significant.

A further experiment designed to ascertain whether it is possible to compensate for the lower yields of late plantings by closer spacings was commenced.

Three sowing dates were used, namely, mid-May, mid-June and mid-July, and three spacings, namely, 3 × 1 ft., 3 ft. × 6 in. and 3 ft. × 3 in.

The lay-out used is a 3 × 3 latin square of sowing dates; each sowing date subdivided into three spacings, the whole being duplicated. Each sub-plot is surrounded by a belt of *Crotalaria juncea* to stop secondary spread of blackarm. Both the May and June sowings have germinated satisfactorily.

The following experiments are referred to in the report on the Bukalasa Experiment Station for January–June 1933.

1. *Sowing Date and Spacing Experiment.*—Lay-out an 8 × 8 latin square ; spacings 4 × 2 ft. and 3 × 1 ft. ; sown in early July, mid-July, early August and mid-August.

The results are shown in the table below :

—	Early July		Mid-July		Early August		Mid-August		S.E. of difference.
	3 × 1	4 × 2	3 × 1	4 × 2	3 × 1	4 × 2	3 × 1	4 × 2	
Mean yield in lb. of 8 sub-plots . .	13·25	14·12	15·12	14·50	14·00	11·37	11·25	10·62	1·4
Lb. per acre .	530·0	564·8	604·8	580·0	560·0	454·8	550·0	424·8	

Early and mid-July gave a better yield than mid-August, whilst early August is nearly significant over mid-August. The indication is that the later the sowing date, the closer, within reason, should be the spacing.

2. *Subsoiling Experiment.*—Lay-out, twelve one-sixth acre strips in A, BB, AA, BB. . . . A pattern. Six of these strips were subsoiled, and six left as controls.

The results were :

—	Subsoiled.	Control.
Mean yield in lb of 6 sub-plots . .	32·8	35·8
Lb per acre	393·6	429·6

These results bear out those obtained in the previous season, when no differences in yield were obtained.

3. *Mulching Experiment.*—The possibility of prevention of soil erosion and maintaining soil fertility by mulching with elephant grass is being investigated. Lay-out : 20 sub-plots of 10 rows each. Planted at the end of July, spacing 3 × 1 ft.

The following results were obtained :

Mean yield of sub plot in lb	1st quality cotton	Stained cotton	Total	Per cent. Stained cotton
Control	39·13	3·77	42·9	8·8
Mulched	38·54	4·36	42·9	10·2

The results of this experiment are negative so far as yield is concerned. This is the first time that mulched cotton has given no increase in yield over the control. An interesting feature of this experiment is the fact that cotton from the mulched plots gave a 3 per cent. higher ginning out-turn than that from controls.

Rubber

Hevea

Ceylon.—The Officer-in-Charge, School Farm and Experiment Station, Peradeniya, in his report for the period January to June 1933, states that the third year of the rubber manurial experiment ended on March 31, and the results have been tabulated for statistical examination and comparison with the records of the two previous years, which were published towards the end of last year (*The*

Tropical Agriculturist, lxxix, 4, pp. 210–219, October 1932). The recorded yields are as follows:

Treatments.[1]	Block 1.	Block 2	Block 3	Block 4	Block 5	Totals.	Mean.
N 1.	1,493	1,406	1,910	1,586	1,333	7,728	1,545·6
N 2.	1,387	1,513	1,980	1,726	1,579	8,185	1,637·0
N.P K.	1,510	1,674	1,813	1,936	1,689	8,622	1,724·4
C	1,511	1,438	1,623	1,666	1,405	7,643	1,528·6

[1] *N1 = Single nitrogen. N2 Double nitrogen, N P K = Complete mixture; C = Control, no manure*

Discussion of the results is held over till they have been examined statistically. Meanwhile the tapping of these trees is being continued, tapping on a new panel being commenced in April 1933.

Drugs and Insecticidal Plants

Artemisia

Ceylon.—According to the report of the Economic Botanist, Department of Agriculture, for the half-year January to June 1933, attempts have been made to grow *Artemisia* spp. for the production of santonin. Numerous samples of seed were obtained from all over the world, but most have failed to grow, and the only ones that have been successfully cultivated have been *A. maritima*, a mixed sample from Persia and a number of strains (species unknown) from India. The *A. maritima* and the Indian forms have failed to set seed at Peradeniya, and as the original number of plants was too small to allow of analysis of flower buds, the work is proceeding under considerable handicap. Attempts are being made to reproduce these forms by cuttings, but the percentage of success is very small. The Persian material grew vigorously and set seed and has been grown on a field scale, but the Agricultural Chemist reports that the flower buds do not contain santonin. A sample has been sent to the Imperial Institute for analysis, and herbarium specimens of all types have been sent to Kew for identification. [The material sent to the Imperial Institute, which had been obtained from an undetermined species of Artemisia, was examined for the presence of santonin by two different methods of analysis, but with negative results in each case.]

Chaulmoogra

Ceylon.—According to the report of the Officer-in-Charge, School Farm and Experiment Station, for the half-

year January to June 1933, most of the Chaulmoogra plants, with the exception of those in the lower-lying swampy portion of the area, have made good growth. Those on the west side, on the slope facing the east, which receive more shade and protection from wind, are definitely superior in growth. It is six years since the oldest plants were planted out and none of them have yet shown signs of flowering. All these plants were raised from seed received from Burma, but some of the older plants appear to be of two types, the typical Burma type and the Assam tyne, as described by Henry in 1926.

Derris

Ceylon.—The Officer-in-Charge, School Farm and Experiment Station, Peradeniya, in his report for the half-year January to June 1933, states that the differences in growth between both species of *Derris* (*D. malaccensis* and *D. elliptica*) under old rubber and out in the open as a pure crop is more marked than ever. Under rubber the above-ground growth of both species is extremely poor, and it has made no headway at all; of the two, *Derris malaccensis* has made the better growth. In the open the above-ground growth has been distinctly good and again *D. malaccensis* has made the better showing of the two; how much this is due to its upright habit compared with the prostrate and very extensive habit of *D. elliptica* will have to be ascertained. The harvesting of both species is being done after definite periods of growth from the time of planting and the sun-dried weights of roots and tops recorded. The growth periods after which harvesting will be done are 16, 20, 24 and 28 months; and analyses of samples from these different growth periods to ascertain their rotenone content is proposed.

Pyrethrum

Ceylon.—According to the report of the Economic Botanist, Department of Agriculture, for the half-year January to June 1933, attempts are being made to cultivate pyrethrum for the production of insecticide. A small quantity of seed was obtained from the Ministry of Agriculture's Laboratory, and was sown at Peradeniya and at Bandarawela (elevation 4,000 ft., average rainfall 70 in.). That at Peradeniya was a failure; very few plants were produced and they quickly died. That at Bandarawela was much more successful; germination was good and healthy young plants have been established. The plants are now about eight months old.

Resins

Lac

Ceylon.—The Acting Entomologist in his report for the first half-year of 1933 states that the cultures of a variety of three-brooded lac (*Laccifer lacca*) imported from Mysore at the beginning of the year were successfully inoculated on *Zizyphus jujuba*, but the insects failed to establish themselves on *Croton lacciferus* and *Schleichera trijuga.* Black ants which also probably contributed to the failure of the inoculations, by destroying much of the lac, were troublesome, but have been kept in check by destroying their nests, when found, by petrol injections, and in other cases by spraying the bases of the affected trees with a coal-tar creosote preparation.

Brooding commenced on Zizyphus in the early part of May and fresh inoculations have been made.

MINERAL RESOURCES

UGANDA

The Institute has received the following report from the Director regarding the work carried out by the Geological Survey of Uganda during the first six months of 1933:

Apart from a visit of inspection to the gold-bearing areas in the Budama District of the Eastern Province in February, the field work carried out by the Director comprised a reconnaissance with reference to the occurrence of gold and iron in parts of Gulu District of the Northern Province, and some geological investigations into the tectonic stability of the proposed dam site at Mutir (*Ann. Rept. Geol. Surv., Uganda*, 1932, paras. 55–57). Advice was given to the Forestry Department in connection with water supply to the Kiterera forestry plantation in the Eastern Province, and some other water problems were dealt with.

Mr. A. D. Combe carried out a geological and prospecting reconnaissance of the Buhwezhu and Bunyaruguru areas of N.W. Ankole, together with a visit of inspection to the Kilembe copper mine in the Ruwenzori mountains. During this inspection the deposits were studied and a very comprehensive series of specimens was collected. A geological and mineral reconnaissance of central Toro was also commenced. The investigations in Buhwezhu resulted in some promising gold discoveries and these are being further investigated, partly in a Government closed

area and partly under Exclusive Prospecting Licences. A representative collection of the tuffs, bombs and agglomerates, etc., of the volcanic fields of N.W. Ankole were collected and despatched to Professor Arthur Holmes of Durham, England, who is studying these petrologically. It would appear that the Toro-Ankole explosion craters probably overlie kimberlite pipes. The geological and mineral reconnaissance of central Toro, which was begun by Mr. Combe during the latter part of the first half-year, had to be abandoned owing to pressure of urgent investigations elsewhere.

Dr. K. A. Davies, whose work during the latter part of the year 1932 resulted in the discovery of good gold values in the Budama District of the Eastern Province, had, unfortunately, to be recalled to headquarters in order to take over the chemical and petrological work, as Mr. W. C. Simmons, who ordinarily performs these duties, was proceeding to England on leave. Dr. Davies took the opportunity to prepare at headquarters some of his maps of the areas investigated by him, and to study the specimens and samples collected.

Two other gold discoveries apart from alluvial deposits were made by the Geological Survey, but their importance or otherwise remains to be investigated.

The first half-year has witnessed a great increase in prospecting on the part of the public and a large number of exclusive prospecting licences and mineral claims have been taken out.

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The Rôle of Salt in Poultry Nutrition. Part I. Salt in the Nutrition of the Chick. Part II. Salt in the Nutrition of the Laying Hen. By J. H. Prentice. *Journ. Min. Agric., N. Ireland* (1933, **4**, 72–104).

The Nutritional Requirements of the Chick. By A. G. Hogan and R. V. Boucher. *Res. Bull.* 189, *Missouri Agric. Exper. Sta.* Pp. 24, 9 × 6. (Columbia: University of Missouri, 1933.)

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Duck Raising. By A. R. Lee and S. Haynes. *Farmers' Bull. No.* 697, *U.S. Dept. Agric.* Pp. 22, 9 × 6. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1933.) Price 5 cents.

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Report on the Agricultural and Marine Products Board, Bahamas, for the year ending December 31, 1932. Pp. 10, 10½ × 7. (Nassau: Colonial Secretary, 1933.)

Annual Report on the Fisheries of New South Wales for the year 1932. Pp. 13, 13 × 8½. (Sydney: Government Printer, 1933.) Price 1*s*. 1*d*.

Report of the United States Commissioner of Fisheries for the fiscal year 1932, with Appendixes. Pp. 586, 9 × 6. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1933.) Appendixes consist of reports for 1932 on the Alaska fishery and fur-seal industries, the fishery industries of the United States, the progress

in biological enquiries and the propagation and distribution of food fishes for 1932.

Fishery Products. *Report No. 69, Second Series, United States Tariff Commission.* Pp. 351, 9 × 6. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1933.) Price 25 cents. Consists in the main of a survey of all the various kinds of marine and fresh-water fishery products of the United States, including descriptions and uses, domestic production, trade and prices. Particulars of production in all countries of the world are also given.

De handel in Schelpen. *Indische Mercuur* (1933, **56**, 642–643; 673–674). An account of the shell industry of the Dutch East Indies.

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Programme of Work of the Division of Forest Products, Council for Scientific and Industrial Research, Australia, for the year 1933–34. Pp. 38, 10 × 8. Mimeographed copy.

Report of the Forestry Commission, New South Wales, for the year ended December 31, 1932. Pp. 13, 13 × 8½. (Sydney: Government Printer, 1933.)

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The Twelfth Annual Report of the Forest Department, Tanganyika Territory, 1932. Pp. 11, 13 × 8. (Dar es Salaam: Government Printer, 1933.) Price 1*s*.

Administration Report of the Conservator of Forests, Trinidad and Tobago, for the year 1932. Pp. 24, 13½ × 8¼. (Port-of-Spain: Government Printer, 1933.)

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Étude des Bois de la Guadeloupe. By J. Meniaud. *Bull. de l'Ag. Gén. des Col.* (1933, **26**, 886–889). A list of the woods of Guadeloupe and their uses.

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Some Experiments in the Control of Dry-rot in Floors. By A. H. Dewar. *Journ. British Wood Preserving Assoc.* (1933, **3**, 22–45).

Interim Report on Work under Project No. 2, Strength Tests of Timbers in Structural Sizes, with Test Results up to 1932. By L. N. Seaman. *Indian Forest Records (Econ. Series—Timber Testing)*, Vol. xvii, Part vii. Pp. 39, 9¾ × 7¼. (Delhi: Manager of Publications, 1933). Price Re. 1 or 1*s*. 9*d*.

Timber Tests: "Damar laut daun besar" (*Shorea glauca* King). Tests on Small Clear Specimens in a Green Condition made at the Timber Research Laboratories, Sentul. *Malayan Forester* (1933, **2**, 137–140).

Review of the Literature on Softwood Distillation. By J. F. Harkom and M. J. Colleary. *Issued by the Forest Products Laboratories of Canada.* Pp. 72, 13 × 8. (Ottawa: Forest Service, Department of the Interior, 1933.)

Gums and Resins

Les Copaliers de l'Afrique Occidentale Françaises. By A. M. Aubréville. *Bull. de l'Ag. Gén. des Col.* (1933, **26**, 982–986).

Lac in Malaya. Part I. Observations on a Lac Insect (*Laccifer javanus* Chamb.) and an Account of Attempts to Propagate it. By N. C. E. Miller. *Bull No. 11, Sci. Series, Dept. Agric., S.S. and F.M.S.* Pp. 24, 9½ × 6. (Kuala Lumpur: Government Printer, 1933.) Price 50 cents.

Tanning Materials

Methode zur Beurteilung verschiedener Gerbstoffe (Katechu-Arten) auf ihren Wert fur die Gerbung der Fischnetze. By J. Olie and G. Brouwer. *Collegium* (1933, **9**, 541–547). An account of a method of determining the relative value of various tanning materials for the treatment of fishing-nets.

The Growing of Wattle and Production of Wattle Bark in Kenya. Revised Edition. By W. G. Leckie. *Bull No 5 of 1933, Dept. Agric., Kenya.* Pp. 19, 9¾ × 6. (Nairobi: Government Printer, 1933.) Price 1*s*.

NOTICES OF RECENT LITERATURE

Books for review should be addressed to "The Editor," Bulletin of the Imperial Institute, South Kensington, London, S.W.7.

A Political Geography of the British Empire. By C. B. Fawcett, B.Litt., D.Sc., Professor of Economic and Regional Geography in the University of London. Pp. xiii + 409, 8¾ × 5¾. (London: University of London Press, Ltd., 1933.) Price 18*s*. net.

In this attractive volume Professor Fawcett has condensed a large mass of information into a small compass, and has presented a concise and illuminating survey of the history, geography, racial and economic factors, systems of government and political conditions of the various parts of the Empire, viz. the United Kingdom, the Dominions

and India, the Colonies, Protectorates, Dependencies and Mandated Territories. The work offers an excellent conspectus of the Empire as it is at the present time, and whilst suitable for perusal as a complete volume it will also prove a very useful reference book for students of Empire geography and politics.

Professor Fawcett's clear presentation of the subject, and his clearly reasoned and suggestive observations on various features of the Empire and its possible future development, make this "study in political geography," as he terms it, a work which deserves a very wide circulation.

AFRICA. By L. S. Suggate, B.Sc. Pp. 378, $7\frac{3}{4} \times 5$. New edition, revised. (London, Bombay, Sydney: George G. Harrap & Co., Ltd., 1933.) Price *6s.*

A notice of the earlier edition of this handy geography appeared in this BULLETIN (1929, **27**, 425). The present edition is virtually the same as the earlier one, and it will suffice to say that it can be strongly recommended to readers in need of a concise and well-arranged account of the various countries of Africa. In the earlier notice it was suggested that a folding map (if possible, coloured) of the entire continent would be a very desirable addition to the work, and it is unfortunate that the book still lacks this useful feature.

MODERN COFFEE PLANTING. By E. G. Windle. Pp. xi + 220, $8\frac{1}{2} \times 5\frac{1}{2}$. (London: John Bale, Sons and Danielsson, Ltd., 1933.) Price 10*s.* 6*d.*

This book is a welcome addition to the literature on coffee production, an industry to which, as regards the British Empire, there was to within less than four years ago a conspicuous dearth of useful guides apart from scattered papers. Two planters, Messrs. J. H. McDonald and F. H. Sprott, have filled the gap for East Africa (see this BULLETIN, 1930, **28**, 252, and 1932, **30**, 519) and now Mr. Windle, a planter of "over fifty years' experience," has done the same service for South India. Planters in the two principal coffee-growing areas of the Empire have now available to them practical guide-books written by fellow planters, in addition to the services of scientific workers.

In South India the co-operation between planters and scientists has recently become closer through the establishment of a central station founded and supported at the

joint cost of the United Planters' Association and the Government of the State of Mysore. It is thus no mere compliment that this book is dedicated to H.H. the Maharaja of Mysore "in grateful acknowledgment of benefit to the coffee industry resulting from the establishment of the Coffee Experimental Station at Balehonnur."

Mr. Windle states that the object before him was to afford a means of avoiding common mistakes and thus "conducing to the smooth running of the estate and the peace of mind of the Superintendent." His method is to write in a free and easy fashion, as one planter to another, on all stages in the cultivation and preparation of coffee.

The practical nature of the book may be indicated by mentioning that after advice on the choice of land, including labour conditions, transport facilities, etc., the author deals with the building of the necessary house and coolie lines, food and health, and then proceeds to the establishment of the nurseries. Felling, roads, drains, lining, planting, etc., come in natural order, and detailed information follows on manuring, diseases and pests, preparation and marketing of the crop. *Estimates of revenue and* expenditure for the first eight years will form a valuable guide for intending planters.

The book is characterised by its presentation of advice born of long practical experience coming from a planter who is obviously in close touch with, and alive to, the value of the latest scientific work.

MODERN FRUIT GROWING. By W. P. Seabrook. Pp. xi + 292, 8½ × 5½. Fourth Edition, Enlarged and Rewritten. (London: Ernest Benn, Limited, 1933.) Price *7s. 6d.*

The appearance of a new edition of this well-known handbook is particularly opportune now that so much more attention is being given to fruit-growing in the United Kingdom. Proof that the United Kingdom can produce fruit of the highest quality and that Mr. Seabrook is well qualified to describe how success can be achieved, is readily forthcoming. A competition is held annually in connection with the Imperial Fruit Show for Dessert Apples grown in the British Empire. Australian, New Zealand and South African entries are judged in the spring, and United Kingdom and Canadian at the Show itself. The awards for 1933, made on score card points, were: First Prize, Messrs. W. Seabrook & Sons, Chelmsford, England, 94¾ points; Second Prize, Messrs. W. Seabrook & Sons and Mr. R. J. Slayter, Nova Scotia, equal 93½ points.

Throughout the book Mr. Seabrook lays stress on the fact that the haphazard production of nondescript fruit is over. With modern facilities for the transport of fresh fruit from far-distant countries, the home grower has to supply standardised produce capable of competing successfully with the pick of the world's fruit. To do this, much more is necessary than merely being able to grow good fruit. To quote the author's words, "there are plenty of really sound growers, who are very fully conversant with, and able to grow, first-class produce, but who fail over the equally important selling end of the business. Probably 25 per cent. of a grower's success is due to grading and 75 per cent. to attention to and skill in picking, grading, storing and marketing his produce."

All phases of the industry are fully and clearly dealt with in a thoroughly practical manner. The prospective fruit grower will find very valuable information in Chapters I, II and XVIII, dealing with the capital necessary, terms of tenure, selection of land and finance. Growers at whatever stage of development will learn much from other chapters in which Mr. Seabrook deals successively with varieties of all the chief fruits, cultivation, manuring, pruning, pests and diseases, spraying, picking, grading, packing, marketing and storage.

The book will be of great value to all actually engaged in or interested in any way in fruit production in the United Kingdom. Much of it also will appeal to growers in other temperate countries.

Apple Pollination Studies in the Annapolis Valley, N.S., Canada, 1928–1932. Pp. 198, $9\frac{3}{4} \times 6\frac{1}{2}$. Dominion of Canada Department of Agriculture, Bulletin No. 162—New Series. (Ottawa: King's Printer, 1933.)

This Bulletin gives an account of a comprehensive investigation of Apple Pollination which has been carried out in Nova Scotia under the direction of W. H. Brittain. In view of its technical nature a popular summary indicating the practical results of the work has been prepared for the use of growers, and is placed at the beginning of the publication.

The introduction to the Bulletin discusses the general features of the apple industry in Nova Scotia having particular bearing on the problem, and gives a brief résumé of factors other than pollination affecting fruit production. The pollination problem in its various phases is outlined in a section entitled "Pollination and Fruitfulness in Apples," which is followed by a detailed

account and explanation of the experiments undertaken in all branches of the problem of apple pollination and a concise summary of the results. In another section, on "Field Studies of Insect Pollination," the rôle of wild insect pollinators is explained and the problems connected with the utilisation of hive bees are illustrated. The work of wild and hive bees in pollinated orchards is fully discussed. Experiments were undertaken to determine the cause and prevention of bee poisoning due to spraying and dusting practice.

Although the work deals with experiments undertaken in Nova Scotia, an attempt has been made to attack the problem from a fundamental standpoint, so that the results obtained are to a large extent applicable wherever apples are grown. Its practical value is greatly enhanced by the charts, diagrams and figures with which it is profusely illustrated, as well as by the useful bibliography and index provided.

SPICES AND CONDIMENTS. By H. Stanley Redgrove, B.Sc., F.I.C. Pp. xviii × 353, 8½ × 5½. (London: Sir Isaac Pitman & Sons, Ltd., 1933.) Price 15s.

The author states that this book has been written primarily for those whose interest in spices and condiments is due to the fact that these products add to the attractiveness of food. Included in this group of persons are grocers, food and flavouring essence manufacturers, housewives, chefs and gourmets. He has also not overlooked the fact that spices are used directly or indirectly as drugs and perfumes.

An introductory chapter is followed by one describing generally the methods of preparing ground spices, essences and essential oils. Then follows a detailed account of all the principal spices and condiments of the world. The treatment of ginger will serve to indicate the scope of the book. An account of the history and ancient uses of ginger is followed by a description of its cultivation and the preparation of the principal commercial products, e.g. dried and preserved ginger; varieties and adulteration, chemical constituents and uses are also fully dealt with. The essential oil of ginger is then similarly treated. Special features of the book are the numerous and excellent illustrations, a bibliography, and botanical, chemical and general indexes.

The author has brought together in very convenient form a mass of information about a group of products which have always been of great interest to all mankind.

British Economic Grasses: Their Identification by the Leaf Anatomy. By Sydney Burr, M.Sc., and Dorothy M. Turner, B.Sc. Pp. 94, 11 × 8¾. (London: Edward Arnold & Co., 1933.) Price 10*s.* 6*d.* net.

The changes which have been taking place in British agriculture for many years past, resulting in the development of grassland farming, have caused increasing attention to be given to the study of grasses as plants of economic importance, and such work has received somewhat unexpected impetus from the need for fuller knowledge concerning the laying down and maintenance of the golf courses and playing fields of all kinds which have become so important a feature of modern social life.

For the rapid and certain identification of the grasses composing pastures and turf some means other than examination of the vegetative and floral characters is essential since these features are often not observable owing either to the season or to the mown condition of the plants.

Professor Stapledon in his Foreword remarks that the identification of the many other plant constituents of a pasture or sward—the clovers and other leguminous plants and the " weeds "—is a comparatively simple matter, but the establishment of the identity of grasses at any stage of growth is a very different question. The anatomy of the leaves of the plants furnishes criteria of the greatest value in dealing with this problem, and the description of the microscopic leaf structure of some fifty-four species and varieties of British economic grasses, combined with diagnostic vegetative characters, forms the subject of this valuable book.

An introduction gives a useful digest of the vegetative characters and of the leaf and shoot anatomy of the grass plant. The identification of the grasses selected is then aided by " keys " based on their vegetative and anatomical characters respectively, and the schemes adopted appear to be simple and effective. The main portion of the book comprises a fine series of plates depicting transverse sections of the grass leaves and shoots, the former being exact representations of the leaves under moderate magnification while the shoot sections are diagrammatic and indicate outline, sheath character and leaf-blade arrangement. Each plate is accompanied by descriptive letter-press on the opposite page.

There is no doubt that this " grass atlas," as it might well be called, will successfully serve its purpose, for the methods required in using it are simple and the guidance

furnished is clear and unmistakable. One comment seems called for, viz., there appears to be no reference to the important work of Lewton-Brain on the leaf structure of British grasses.

FUNDAMENTALS OF FIBRE STRUCTURE. By W. T. Astbury, M.A. Pp. ix + 187, $8\frac{1}{2} \times 5\frac{1}{2}$. With an Introduction by Sir William Bragg, K.B.E., O.M., F.R.S. (Oxford: The University Press; London: Humphrey Milford, 1933.) Price 8*s.* 6*d.*

This book is based on a course of six University Extension Lectures which the author gave in 1932 to textile students and operatives at the Spenborough Technical School, Cleckheaton, Yorks.

In his preface, Mr. Astbury says, "I have tried to tell the story in the simplest possible terms, starting from the very beginning for the benefit of those who have no textbook science at all." With this object in view the first three lectures are devoted to such elementary chemistry and physics as is considered essential to an understanding of the methods of X-ray analysis when applied to crystals and extended to textile fibres. In this connection it may be pointed out that the fibres are regarded as crystalline in the sense that they are composed of structural units known as "micelles" in which the component atoms and molecules are arranged in regular systematic order. The assumption that the members of the author's audience had no elementary knowledge of science is seen in such statements as the following:

"Just as the word 'cat' is made from three letters *c*, *a* and *t*, so a molecule of *caustic soda*, for instance, is made by the combination of three atoms, one of the element *sodium*, another of the element *oxygen*, and another of the element *hydrogen*."

"Just as CAT spells cat, so NaOH spells one molecule of caustic soda."

"Hydrogen and oxygen are both colourless gases and of no particular use to a thirsty mortal so far as his thirst goes; but every molecule of water contains two atoms of hydrogen and one atom of oxygen."

"Positive electricity repels positive but attracts negative electricity; while negative electricity repels negative electricity but attracts positive."

It seems doubtful whether from these three lectures, although written in the simplest possible manner, the student (with "no textbook science at all") would gain a sufficiently clear understanding of the underlying scientific

principles to enable him to follow the somewhat abstruse and complicated details given in the fourth, fifth and sixth lectures, dealing respectively with " An X-ray View of the Inside of a Textile Fibre," " The Fundamental Structural Difference between Wool and other Fibres," and " Some Inside Information about the Properties of the Wool Fibre." To a scientifically trained mind, however, the information is of great interest as the methods of research and the deductions drawn from experimental observations are lucidly explained, and the book can therefore be confidently recommended to scientific workers desirous of obtaining a knowledge of the application of X-ray research to the study of the fundamental structure of textile fibres. The work is well illustrated with diagrams and X-ray photographs and contains a useful bibliography.

Buch der Holznamen. By Dr. Hans Meyer. I. A-Ca. Pp. xviii + 108 ; II. Cé-Ise bubaki. Pp. 109-232, 10 × 7. (Hanover : Verlag von M. & H. Schaper, 1933.) Price M. 6.50 each part.

There has been no lack of effort in recent years to provide lists of names of timbers intended to furnish convenient reference works giving the common or trade names and botanical identifications of woods met with in commerce. Such lists have been called for as a result of the increasing attention being paid in several countries to the commercial utilisation of a rapidly growing number of timbers—largely from tropical colonies—and a further demand for authoritative nomenclature has arisen in consequence of the discriminating tariff regulations affecting timbers of different classes which have been formulated in a number of importing countries. The author rightly points out that the lists of names hitherto published have been concerned with species imported by, or of interest to, a particular country, or confine themselves to certain limited territories of origin.

The present work would appear to aim at listing all the timbers of the world having commercial or technical significance and no further comment need be made as to the magnitude of the task. The first two parts under notice include in 232 pages upwards of 13,000 references. Each reference takes the form of (*a*) the " common " local or trade name, (*b*) the botanical name, (*c*) the botanical natural family of the tree and (*d*) the country of origin. The following examples will illustrate the method : (i) Beech, Southland : *Nothofagus menziesi* Oerst. ; *Fagac.* ; N.-Seel. (ii) Greywood, Silver, Indian : *Terminalia bialata* Wall. ; *Combretac.* ; Ind.

The preface and list of abbreviations used in the book are printed in German, English, French and Spanish.

This handbook when complete will be of the greatest service to all workers dealing with timbers.

Controlling Plant Pests in Southern Africa. A Handbook for the Fruitgrower, Orchardist, Gardener and Grower of Field Crops. Pp. 199, $9\frac{1}{2} \times 6$. (Johannesburg: Cooper & Nephews, S. Af. (Pty.) Ltd., 1932.) Price 3*s*.

This handbook, which is none the less useful for being concerned largely with the products of a particular commercial organisation, gives in a convenient form, with copious illustrations, such information as is necessary in order to deal effectively with the plant enemies that are the principal causes of damage to fruit and other crops in Southern Africa.

It is concerned principally with spraying, but other methods, such as the use of baits for insects, are described where they are appropriate. The longest chapter is one entitled "Principal Insect Pests." This describes a large number of pests with their habits and the methods recommended for controlling them. It is followed by a chapter dealing similarly with diseases. Other chapters are devoted to equipment used in spraying and to the economics of spraying; and at the end of the book are charts summarising in tabular form the procedure for dealing with the different pests and diseases, and "reminders" appropriate to each month of the year.

The price of the book is likely to commend it to many who may not be inclined to purchase the more expensive treatises.

Dairy Bacteriology. By Orla-Jensen, Dr. Phil., D.Sc. Translated from the Danish by P. S. Arup, M.Sc., F.I.C. Second English Edition. Pp. x + 198, $9\frac{3}{4} \times 6$. (London: J. & A. Churchill, 1931.) Price 18*s*.

The present edition of this work, of which a copy has just been received at the Imperial Institute, is an entirely new one, Professor Orla-Jensen having revised and added to the text in order to bring it thoroughly up to date before translation. It is essentially a textbook for the use of students of Dairy Science and, based as it is on the author's own experience culled from thirty-five years of research work, it admirably fulfils this purpose.

The first part deals generally with micro-organisms, their nutrition and growth, enzymes, methods of culture and examination, the different types of bacteria and the

fermentations which result from their action, and the species of yeasts and moulds commonly found in milk and dairy products. The remainder of the book discusses the practical application of a study of these micro-organisms in relation to the production of milk and the manufacture of butter, cheese, etc. The subjects dealt with include the cleaning and production of milk, the normal and abnormal microflora of milk, its preservation and treatment for direct consumption, the applications of lactic acid fermentation in the dairy industry, the microflora of butter, the ripening processes of the different kinds of cheese and their defects, and finally the various tests used to judge the cleanness and freshness of milk and its suitability for making good dairy products.

Allen's Commercial Organic Analysis. Volume X. Hæmoglobin and its Derivatives, Albuminoids or Scleroproteins, Structural Proteins, Examination of Foodstuffs for Vitamins, the Hormones, the Identification of Unknown Woods and Charcoals, the Pectic Substances. By various authors. Fifth edition, revised and partly rewritten. Pp. xi + 816, $9\frac{1}{4} \times 6$. (London: J. & A. Churchill, 1933.) Price 32*s*.

This volume completes the present edition of this well-known work. It was intended to conclude the subject of proteins in the previous volume, but owing to the large amount of new material which had to be introduced, the size of that volume would have been disproportionately large. The sections on the proteins have therefore been distributed between three volumes, two sections in Vol. VIII, five in Vol. IX, and three sections in Vol. X. Of the present three sections, the first on Hæmoglobin and its Derivatives by J. A. Gardner, M.A., F.I.C., and G. A. Buckmaster, M.A., M.D., D.P.H., and the second on Albuminoids or Scleroproteins, comprising collagens, glue and gelatin, chondrigen and chondrin, and mucins, by J. Alexander, M.Sc., have been revised respectively by the original authors. The order and general arrangement of these two sections has been maintained; they contain the same tables and illustrations but much new material has been added to the text.

The section dealing with Structural Proteins was formerly contributed by W. P. Dreaper, O.B.E., F.I.C., and has been revised by R. H. Marriott, M.Sc., A.I.C. The latter has retained as much as possible of the original, but there are considerable alterations and additions. The sub-section on artificial silk, a product which one would

hardly expect to find under the heading of Structural Proteins, has been entirely rewritten, and extended to twenty pages, or more than twice the space it previously occupied. Moreover a new and useful illustrated sub-section on the examination of furs has been added.

As indicated in the preface, this volume is more miscellaneous in character than the preceding volumes, and owing to advances in science it contains some entirely new sections.

The section on Vitamins has been contributed by J. C. Drummond, D.Sc., F.I.C., and Katharine H. Coward, D.Sc. It deals with the more important facts concerning the vitamins, and gives a good account of the present biological and other known methods for their estimation. The authors admit that " in many respects the methods at present in use are unsatisfactory," but state that " the rate at which progress is being made in effecting improvements is such as to encourage the hope that reliable and generally improved techniques will soon be available."

The Hormones, or the active principles of the glands of internal secretion—another important subject which has come into prominence during the last few years—is well presented by Kathleen Culhane, B.Sc., A.I.C., and S.W.F. Underhill, M.A., M.B., B.Ch. The authors describe the methods of preparing hormones, their properties, estimation, uses and toxicology. They point out that " in the case of the majority only physiological methods are available for their identification and estimation of the active principles and even when the hormone has been obtained in crystalline condition physiological tests are generally necessary and always desirable."

J. C. Maby, B.Sc., A.R.C.S., contributes an interesting and instructive section on the Identification of Unknown Woods and Charcoals which is based chiefly on their anatomical structure, but approved physical and chemical methods of identification are also described. A hand-lens " Key " or schematic aid to thirty-five European woods is appended.

The last section in this volume, on the Pectic Substances, is furnished by H. W. Buston, Ph.D., D.I.C. As stated by the author " only during recent years has any complete understanding of the chemistry of these substances been approached, and their industrial use rendered possible." After detailing the different groups of pectic substances generally recognised, their chemical constitution and distribution are discussed. Useful information is supplied regarding the methods of extraction of pectins, their preparation, characterisation and estimation. Par-

ticulars of the conditions governing the formation of pectin-sugar jellies are given, and methods of assessing the value of pectin preparations for jelly-making are described. Enzymes and hemicelluloses which are associated with the pectins are also dealt with.

At the end of each section, a useful bibliography is provided. About one-third of the book is occupied with the index to this volume and a general index to the whole ten volumes. The work will continue to be of great service to chemists and should find a place on the shelves of all those engaged in commercial organic analysis.

MINERAL DEPOSITS OF THE CANADIAN SHIELD. By E. L. Bruce, B.Sc., Ph.D. Pp. xxiv + 428, 9 × 6. (Toronto: The Macmillan Company of Canada, Limited.) Price 25*s*. net.

The idea of collecting the information available on the mineral deposits of the Canadian shield into one volume is excellent. It is of the greatest interest to be enabled to see at a glance, so to speak, exactly what one of the largest and most typical of the ancient and rigid crustal masses known as "shields" has yielded in the way of mineral wealth.

The introductory chapters, occupying about 100 pages, deal with such general questions as rock-magmas and the phenomena displayed by them during consolidation, the zonal arrangement of mineral deposits, the formation of minerals including replacement phenomena, and the various factors involved in rock alteration.

For the purpose of description the shield is divided into eight units, viz., Labrador and the Lower St. Lawrence Valley, the Grenville Sub-Province, the Timiskaming Sub-Province, the Area North of Lake Huron, the Lake Superior Region, the Lake of the Woods and Rainy Lake Region, the Patricia – East Manitoba Region, and Northern Manitoba. This is partly a geographical, and partly a geological classification, the Grenville Sub-Province, for instance, including south-eastern Ontario, western Quebec, the Adirondack region of New York and other areas. Difficulties of correlation were probably against treatment on a purely geological basis. The title of the first unit is somewhat of a misnomer, since it consists of a description of the St. Urbain and Ivry ilmenite deposits, without general introduction and with no mention of Labrador. In general, however, an account of the geology of each unit is followed by descriptions of deposits according to minerals worked. Details are then given of the geology of mines

belonging to each sub-class. Theories of genesis for all types of deposit are given detailed consideration, and the author's own views, which generally emerge in his summary of the ideas of other workers, are full of sound common-sense. Some of the most important and interesting mineral fields in the world occur in Canada's pre-Cambrian, and Professor Bruce takes full advantage of the wonderful scope afforded him.

The book is well-produced and illustrated, and although no regional maps or general map are given, apart from a frontispiece diagram, the book will be of great service to mining geologists and students, and to field men whose work lies in areas of pre-Cambrian rocks.

Ores and Industry in the Far East. The Influence of Key Mineral Resources on the Development of Oriental Civilisation. By H. Foster Bain, with a chapter on Petroleum by W. B. Heroy. Revised and Enlarged Edition. Pp. xvi + 288, 9 × 6. (New York: Council on Foreign Relations, Inc., 1933.) Price $3.00.

This valuable survey of the mineral position of the Far East, and particularly of China and Japan, was received with some surprise on its first appearance in 1927. The world had become accustomed to think of the hinterland of China as a repository of undiscovered mineral wealth, and to base its ideas of the power and wealth of an awakened China on these hypothetical resources. Mr. Foster Bain claimed then, and in this new edition the lesson is further driven home, that it is now safe to say that the Far East is not overwhelmingly rich, but is comparatively poor, in mineral resources. He is quite definitely of the opinion that the mineral resources of the Far East are not sufficient to render possible its industrialisation on the scale prevailing in Western Europe and North America. The criticism has been made, that on the work so far done in China, Mongolia and Siberia, we can by no means be so certain as Mr. Bain appears to be, that important discoveries of coal and iron and the base metals will not be made. American economic mineral surveys, such as that led by Mr. Bain himself, have covered a comparatively small area of China, whilst the Chinese Geological Survey, valuable though its work has been, is grounded on a primarily academic basis.

In reply to this criticism, it is pointed out that in every important mining district from Japan to Java, ancient workings are the guide to ore, except for such minerals as have only recently come into use, and for petroleum; and

it is stated that on these grounds there is no reason to anticipate the finding of further great deposits. Furthermore, the pertinent point is made that large bodies of high-grade iron ore, for instance, in remote regions and unaccompanied by coking coals, are of little use to humanity now or in the future. China's coal resources are well known, and appear immense on a tonnage basis. W. H. Wong, Director of the Geological Survey of China, has stated that they are sufficient to last 2,000 years at her present rate of consumption, for seventy years at the United States rate of consumption, and for only sixteen years if the per capita rate of consumption of the United States is applied to the population of China. It is only fair to state, however, that much higher estimates have been made than those of Wong.

In the present edition, the chapters on Coal, Iron and Steel, Petroleum, Sulphur and Sulphides, Non-Ferrous Metals, Non-Metallic Resources, and Conditions Affecting Mining Development, have been revised as to matter and statistics. A chapter is devoted to Manchuria and Jehol, which have recently come into prominence in connection with Japanese expansion. The introductory and concluding essays on Minerals, the Basis of Modern Industry, and What of the Future? are valuable and interesting, and the book as a whole should be of the greatest interest to oriental sociologists and all students of world affairs, but more particularly those in the mining profession.

History of the Theory of Ore Deposits; With a Chapter on the Rise of Petrology. By Thomas Crook, A.R.C.S., F.G.S., M.I.M.M. Pp. 163, $8\frac{1}{2} \times 5\frac{1}{2}$. (London: Thomas Murby & Co., 1933.) Price 10*s*. 6*d*. net.

In this book an account is given of the history of the controversy on the subject of the origin of metalliferous veins, a subject on which opinions have been divided since early days. The ancients, as represented by Aristotle and others, had few facts to guide them in their speculations. Not until the time of G. Bauer (Agricola) in the sixteenth century, do we see any substantial development of a basis of fact for theorising. Agricola quite definitely sought to secure such a basis of fact for his view that the rock juices, from which minerals were deposited, arose from the solvent action of meteoric waters which, after percolating downwards, were thrown surfaceward sometimes as hot springs, after circulating at depth.

Descartes, in the following century, called into action the residual internal heat of the earth, and the emanation

of magmatic vapours, to account for lode formation. This notion of the direct magmatic origin of lode minerals is the one that has been most successful. It has appealed strongly to the taste of mining geologists and engineers, who find in it a satisfying assurance that the veins they exploit are likely to extend in depth.

In this, as in many other human beliefs, the wish is often father to the thought; otherwise, it is difficult to understand how, in spite of much reason and experience to the contrary, the notion of the juvenile origin of the water and metals involved in lode formation could have survived so long. It is so very comforting, for instance, for owners of gold mines in any region to be assured, as some assure them, that the lodes they exploit were deposited during the great "Chrysogenetic Epoch," a sort of golden age when huge deep-seated batholiths of continental extent forged their way upward in the earth's crust, drenching the superincumbent rocks with auriferous solutions and depositing their metalliferous load in quartz veins. This is a view of things which is quite solemnly advocated by some writers at the present day, and serves as a basis of irrational optimism in some cases.

The fact that mining engineers usually insist, and rightly so, on trying to understand the genesis of the lode deposits they have to exploit, makes it desirable that they should consider carefully the views that have been set forth at various times to explain the origin of metalliferous veins. The author has given in this book a very readable account of the history of the growth of ideas on the origin of metalliferous veins. The book may be strongly recommended to mining geologists and engineers as a course of reading in which they are likely to find much that will interest them and broaden their views.

Cours de Géologie Appliquée Professé a L'École Supérieure des Mines. By L. de Launay. Notes prises et rédigées par Henri Vincienne. Pp. 460. $9\frac{1}{4} \times 6\frac{1}{4}$. (Paris et Liege: Librairie Polytechnique Ch. Beranger, 1933.) Price Frs. 90.

This book gives one the impression of being a sort of short summary of the author's well-known *Traité de Métallogenie*, to which the reader is referred for fuller details.

Introductory chapters on generalities (pp. 1–70) include accounts of the distribution of elements, geological processes, and types of mineral deposits. Then follows the chief part of the book (pp. 71–417) which deals with mineral

substances under the elements chiefly concerned. The plan adopted throughout this portion of the book is to deal with (1) Uses, (2) Statistics and (3) Deposits, under each mineral. A concluding chapter (pp. 418–440) deals with hot springs and underground waters.

The book is far from being up to date and leaves much to be desired. One would expect a French work on this subject to say something about the conditions of occurrence of Madagascar graphite. This and other omissions suggest that the *Traité* has been summarised without bringing the matter up to date. No account is given of Climax molybdenite or of the Chinese wolframite deposits and many other important deposits that are exploited for minerals at the present day. There is scarcely a chapter dealing with mineral substances which does not show such omissions, which seriously diminish the value of the book.

Should a second edition be called for, it is highly desirable that the author should bring the book up to date and give some account of many important occurrences of minerals that have been ignored in this edition.

A TEXTBOOK OF GEOLOGY. PART II—HISTORICAL GEOLOGY. By Charles Schuchert and Carl O. Dunbar. Pp. vii + 551, 9 × 6. Third Edition, Largely Rewritten. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1933). Price 25*s*.

The story of the evolution of the earth is one of absorbing interest, and in this third edition of a well-known textbook, which might also be called a new book, the story has been exceptionally well told. As a history it is not complete, nor does it claim to be so, but as an elementary treatise and an account of historical geology it is an admirable work. The text is excellently illustrated with 332 figures and 35 plates, which include many fine photographs, restorations of life and landscapes in various periods, and palæogeographic maps.

In general the book is concerned with North America and there is but little mention of the rest of the world. The economic resources of each period are briefly reviewed and many references and suggestions for collateral reading are given. The book is well balanced and has useful introductory chapters on fossils, evolution, the origin of the earth and the table and length of geologic time. There is also an appendix on the study of animals and plants and a useful index, and altogether the book provides a most attractive means of study for geological readers.

ON THE MINERALOGY OF SEDIMENTARY ROCKS; A SERIES OF ESSAYS AND A BIBLIOGRAPHY. By P. G. H. Boswell, A.R.C.S., D.I.C., F.R.S., Sec. G.S. Pp. ix + 393, $8\frac{1}{2} \times 5\frac{1}{2}$. (London: Thomas Murby & Co., 1933.) Price 21s. net.

The larger part of this book (pp. 129–363) consists of bibliography and abstracts, arranged alphabetically under authors' names. The subject has for some years proved a fruitful and very easily exploited field of investigation, and in consequence of this there has been a veritable spate of papers giving accounts of the mineral composition of sediments, and attempting to use this as a basis of correlation and inference as to derivation. As a guide to this literature, the bibliography with abstracts will prove useful to workers on this subject, since the abstracts are serviceable enough to render further reference unnecessary in many cases.

By way of preface to these abstracts, the author gives (pp. 1–125) a series of what he calls short essays, in ten chapters, in which he has "endeavoured to invest the abstracts with some significance by showing what has been accomplished in the field of the petrology of sediments and what is the trend of thought at the present time."

The author himself has specialised on this subject for many years, as may be seen from the fact that the abstracts include no less than thirty-seven of his own papers. He has indeed been one of the most diligent reapers in this field of work, and must on that account be regarded as an experienced guide.

A long index in six parts, covering pp. 364 to 393, concludes an excellently printed work that is likely to be found very useful to students interested in the mineralogy of sedimentary rocks.

A DESCRIPTIVE PETROGRAPHY OF THE IGNEOUS ROCKS. VOLUME II. THE QUARTZ-BEARING ROCKS. By Albert Johannsen, Ph.D. Pp. xxxi + 428, $9\frac{3}{4} \times 6\frac{3}{4}$. (Chicago: The University of Chicago Press; London: Cambridge University Press, 1932.) Price 33s.

This important work is designed to occupy four volumes. Volume I dealing with "Introduction, textures, classification and glossary" appeared in 1931. Volume II, now under notice, presents a systematic description of the quartz-bearing igneous rocks; while the remaining two volumes, which have yet to be published, will deal respectively with neutral rocks, and felspathoid rocks and perknites. A complete index is promised in Volume IV.

Throughout the present work and in the succeeding volumes, rock descriptions are arranged according to the author's own quantitative mineralogical system of classification, whereby rocks are divided into classes, orders, families and sub-families. The position of any rock in this classification is indicated by a number composed of either three or four digits, the first digit representing the class, and indicating whether the rock is leucocratic, mesocratic, melanocratic, or composed entirely of "mafites." The second digit represents the order, and indicates whether the rock contains albite, oligoclase-andesine, bytownite-labradorite, or anorthite as its plagioclase-felspar. The third and fourth digits denote the family or sub-family, the latter being further indicated by means of a special symbol. Following the last digit there is added in most cases the letters P, E, H, A or D, indicating whether the rock is plutonic (P), extrusive (E), hypabyssal (H), aschistic (A) or diaschistic (D). A rock with the number 226P thus indicates that it is plutonic of class 2, order 2, family 6, i.e. granite.

This system of classification is established on purely arithmetical lines on the basis of the minerals actually present in the rock. Owing to the large number of divisions or pigeon-holes made available in which rocks may be placed, the author has been obliged to coin a number of new names. It is doubtful, however, whether such terms as leuco-calciclase-syenogabbro or mela-sodaclase-syenodiorite carry a very definite meaning to anybody, or whether the fundamental differences in rocks are sufficient to justify the large number of pigeon-holes that are characteristic of this system. Moreover, the fact that a relatively large number of these divisions are at present left empty, is indeed significant, although in fairness to the author it should be remembered that rock descriptions are often vague and unsatisfactory.

Whether or not this classification of igneous rocks be generally accepted, the present volume, dealing as it does with the quartz-bearing rocks included in families 0 to 8, ranging from greisen (110P) to quartz-calciclase-gabbro (248P), contains an excellent summary of the available information. The description of granite and its varieties occupies no less than 136 pages, and contains valuable observations regarding the nomenclature and history of the rock, megascopic and microscopic characteristics, chemical composition, alteration and genesis. The work is fully annotated and contains 120 beautifully reproduced illustrations, including 32 interesting portraits of well-known petrographers.

Elements of Optical Mineralogy. An Introduction to Microscopic Petrography. By Alexander N. Winchell. Third edition. Part II. Descriptions of Minerals. Pp. xviii + 459, 9 × 6. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd.) Price 37*s.* 6*d.*

The second edition of this volume, published in 1927, was noticed in this Bulletin 1928, vol. 26, p. 131.

Besides the increase in the number of pages due to the inclusion of minerals recently described and to the additional data now available on some of the other minerals, the present volume differs in several important respects from its predecessor.

The main difference lies in the method of classifying the silicates, which are now grouped according to their structure as revealed by X-rays. The classes are (1) Silicates containing separated SiO_4 groups (including the garnets and olivines); (2) Silicates containing separated Si_2O_7 groups; (3) Silicates containing separated Si_3O_9 or Si_6O_{18} rings (none containing separated Si_4O_{12} rings are yet known); (4) Silicates containing separated SiO_3 chains (including the pyroxenes); (5) Silicates containing separated Si_4O_{11} bands (including the amphiboles); (6) Silicates containing separated Si_4O_{10} sheets (including the micas); and (7) Silicates containing n (Si, Al)O_2 frameworks (a large group containing the felspars, felspathoids, zeolites, etc.) Descriptions of a large number of silicates whose structure has not yet been elucidated by X-ray methods occupy the last 42 pages of the book. In most cases the change has merely necessitated the rearrangement of descriptions given in the previous edition in a fresh order, but in the case of the amphiboles much of the text has been rewritten. A fresh set of chemical formulæ has been devised for the series; thus for example magnesian anthophyllite, formerly written $MgSiO_3$, now becomes $H_2Mg_7Si_8O_{24}$ or $(OH)_2Mg_7(Si_4O_{11})_2$, and practically the whole series is now regarded as containing (OH) groups. The pyroxene and amphibole groups now consist of orthorhombic and monoclinic minerals only, all the triclinic minerals formerly included in these families being now relegated to the group of minerals whose X-ray structure has not been sufficiently worked out.

A more reasonable nomenclature has been adopted for many minerals in the present volume, such names as spodumenite, cinnabarite and alunogenite being dropped.

The present edition is an even more complete and useful compilation than its predecessor.

THE ECONOMICS OF MINING (NON-FERROUS METALS). VALUATION—ORGANISATION—MANAGEMENT. By Theodore Jesse Hoover. Pp. viii + 547, 9 × 6. (California: Stanford University Press; London: Mr. Humphrey Milford, Oxford University Press, 1933.) Price *29s. 6d.*

Most young engineers will find this introduction to the business side of mining of value and assistance to them. The author describes in simple and interesting language some of the fallacies and pitfalls in the profession; he exposes many of the common sharp practices, and discourses on the ethics of an engineer. The text is replete with anecdotes and examples; the chapter on fakes and fallacies is particularly interesting in this respect and mentions rhabdomancy and dowsing by the use of such unusual instruments as Knackwurste (saveloys) and candle-snuffers.

The book is divided conveniently into three parts; the first, with ten chapters, is entitled Mine Valuation and deals with sampling, ore reserves, costs and values, marketing, metal prices and reports. Part Two, with eight chapters, is entitled Mine Organisation, and describes the development of the modern company system, the promotion and valuation of enterprises, and introduces some aspects of mining law as affecting the mining engineer in the United States. In Part Three, entitled Mine Management, a further eight chapters deal with staff organisation, scientific management, research, safety and health. The mining engineer's career also receives full attention in this part of the volume.

Each part is complete in itself and each chapter is followed by a fairly comprehensive bibliography; this feature and a comprehensive index at the end serve further to enhance the value of a book which is both instructive and entertaining.

THE PORPHYRY COPPERS. By A. B. Parsons. Pp. xv + 581. 9 × 6. (New York: The American Institute of Mining and Mechanical Engineers, 1933.) Price $5.00.

This is the first of the Rocky Mountain Fund Monographs to be published by the American Institute of Mining and Metallurgical Engineers. In 1928 the Rocky Mountain Club and the Institute agreed to amalgamate and to place the residual finances of the Club in a special fund for publication purposes. The costs of publication of the present work have been met by this fund, as also will be those of other volumes dealing more particularly with mining

problems of the Western States of America. The whole series promises to be of outstanding interest.

The present work passes in review twelve of the great copper mines in the Cordilleran regions of North and South America. These mines, in the order of their respective ages are: Utah, Morenci, Nevada, Braden, Miami, Ray, Chino, Inspiration, Chuquicamata, New Cornelia, Copper Queen and Andes, the first commencing production in 1905 and the last in 1927. The essential characteristics of the associated ore-bodies which are universally, if not quite precisely, designated as "porphyry coppers" are: their huge size, especially in respect of horizontal dimensions; the relative uniformity with which the copper minerals have been disseminated or "peppered" throughout the mass; the low average copper content of the mass, which is probably nearer 1 than 2 per cent. (with 3 per cent. as the maximum); and their association with an intrusion of porphyry or closely related rock that has played a vital part in the genesis of the ore. Secondary processes have, however, played an important rôle in the enrichment of the primary sulphide ore (pyrite and chalcopyrite), the minerals mined being usually chalcocite, chalcopyrite, covellite and bornite.

The total production of the above twelve mines up to the end of 1931 is given as approximately 8¾ million short tons, in terms of metallic copper, equivalent to some 14 per cent. of the estimated recoverable content of the ore-bodies. Of this total, 7¾ million tons, valued at about £7 million sterling, were produced during the 17-year period from 1915 to 1931, and represent 31 per cent. of the world's production of copper for the same period.

Such, in brief, is the amazing development of the "porphyry mines" of the Cordilleras; the methods by which this has been done and something of the men who brought it about, of the discouragements and successes they met, are vividly told in this book, which makes very interesting reading.

DAS RHENIUM. By Ida and Walter Noddack. Pp. viii + 86. 9¾ × 6¼. (Leipzig: Verlag von Leopold Voss, 1933.) Price Rm. 7.80.

Rhenium was first isolated and many of its compounds prepared by Ida and Walter Noddack, the writers of this treatise. They have produced a complete account of the chemistry of rhenium and its compounds in which their pioneer work on the isolation of this element is fully described. A section dealing with the geochemistry of

rhenium is also included and a complete bibliography, containing references up to March 1933, is appended. That such a large amount of information about rhenium is now available is a tribute to the skill and perseverance of the authors, who so ably paved the way for later investigators.

The existence of a higher homologue of manganese, to fill a gap in Mendelejeff's Periodic Table, was predicted by him in 1869, and a number of unsuccessful attempts to isolate the missing element were made, but finally, at the end of 1926, Ida and Walter Noddack isolated 2 milligrams of a pure element, agreeing in properties with the element predicted by Mendelejeff, for which they proposed the name Rhenium. They had previously, in 1925, proved the existence of this element by obtaining the characteristic lines of its X-ray spectrum, but the rare earth and platinum minerals they employed as raw materials had to be concentrated still further before weighable amounts of the new element were obtained. Some idea of the difficulty of the work and of the scarcity of the element may be obtained from the fact that 660 kilograms of molybdenite, which was found to be the richest natural source of rhenium, yielded 1·7 grams of the element after a number of laborious chemical separations. Using the material so obtained the authors studied the properties of rhenium and a number of its compounds.

In the smelting of a cupriferous shale from Mansfeld a molybdenum-bearing by-product was obtained, which was worked up for cobalt, nickel and molybdenum by the Vereinigten Chemischen Fabriken of Leopoldshall. W. Feit in 1929 discovered that this residue was richer in rhenium than any known mineral and this element is now being extracted from it by the above firm, who are able to maintain a yearly output of 120 kilograms of potassium perrhenate. Metallic rhenium is being sold at 13 marks per gram, a very low price considering its scarcity.

It is early yet to consider the possibility of any extensive commercial application of rhenium, but the firm of Siebert of Hanover is already manufacturing thermocouples of a platinum-rhenium alloy which is claimed to be superior to the platinum-iridium alloy now in use.

Rhenium appears to form seven series of compounds, in which it possesses all valencies from seven down to unity, and a very large number of compounds are thus possible. Only a few of these have yet been investigated and much work still remains to be done. This book will prove of service to students and research workers and will no doubt encourage further work on this interesting subject.

INDIA MICA. Vol. I. The Trading, Manufacture and Utilisation of Natural and Built-up Mica. By Ramani Ranjan Chowdhury. Pp. iv + 103, $8\frac{1}{2} \times 5\frac{1}{2}$. (Calcutta: The Economic Supply Agency, 1932.) Price *7s. 6d.*

This little book has been written by an Indian for the benefit of his fellow-countrymen, with the object of bringing home to them the importance of Indian mica in the rapidly expanding electrical industries of the world.

The subject-matter is treated of in nine chapters dealing with the occurrence of mica in India with statistics of production and export; the various kinds of mica, and their chemical and dielectric properties; the preparation of mica for the market, including detailed information as to the methods of trimming and grading by size and by quality; the manufacture, grading, and packing of splittings; the utilisation of scrap mica; the properties and uses of sheet mica, with commercial specifications; the manufacture and uses of built-up mica, or micanite. There are also several appendices which contain the provisions of the Bihar and Orissa Mica Act of 1930, details of royalties on Indian mica, the duties on mica imported into India, the duties on mica imported into the U.S.A. and other countries, a table of average shipments and values of Indian mica, a table of production of mica in the British Empire and Madagascar, a chart for grading mica according to the Bengal system, a comparative table showing grading systems in use in various countries, a table of world's production of mica from 1919 to 1928, a list of the principal Indian mica exporters, and a brief list of countries of the world in which mica occurs.

The book contains much information likely to be useful to those for whom it was written, but it makes little or no contribution to the knowledge already available on the subject of Indian mica. Moreover, its pages are marred by numerous mis-spellings, oddities of expression and literary defects Thus, the introductory paragraph in Chapter II, which deals with the derivation of the word mica, is headed " Nemesis "; on page 19 we have the phrase " Maximum withstandability of temperature "; on page 2 occurs the statement that " this wonderful mineral substance can be made to take any size, shape or thickness from the flimsiest but perfect sheet, that can be blown away with the breath like a toy balloon—to a solid adjunct that is capable of stopping a bullet "; on page 39 it is stated that " in Madras, Mica is also cut into irregularly rounded shapes—which has preference for certain purposes, requiring to punch dimensions out of it."

The publisher would be well advised to engage a reader

for the purpose of eliminating these and other defects from any future editions he may issue.

PRECIPITATED CHALK. History, Manufacture and Standardisation. By A. P. Wilson, M.A. Pp. 51, 9 × 6. (Birmingham: John & E. Sturge, Ltd., 1933.) Price 2*s*. 6*d*.

This booklet deals briefly in the first four chapters with the properties and uses of Sturge's Precipitated Chalk. A fifth chapter on chalk testing describes in some detail two physical tests for the determination of the dry bulk of precipitated chalk at a standard degree of compression and its water-absorption value under standard conditions.

The book concludes with a section on the determination of the chemical purity of chalk and gives useful tables of densities, etc. It contains a number of good photomicrographs and should be of use to those interested in the commercial applications of precipitated chalk.

SPECTROSCOPY IN SCIENCE AND INDUSTRY. By S. Judd Lewis, D.Sc. (London), D.Sc. (Tubingen), F.I.C., Ph.C. Pp. vi + 94, 7½ × 5. (London: Blackie & Son, Ltd., 1933.) Price 3*s*. 6*d*.

Dr. Judd Lewis, the well-known authority on spectroscopy, has attempted in this little book to give an account of modern spectroscopy, with special reference to its industrial applications. Very small amounts of impurities have been found to exert a surprisingly large effect in modifying the properties of metals, glass and numerous other inorganic materials, and the necessity for developing methods for detecting and estimating traces of such impurities has given an impetus to the study of spectroscopic methods of analysis. Development has been so rapid that many chemists who do not usually employ the spectroscope will welcome this concise account of modern methods.

It would be unreasonable to expect more than an outline of spectroscopy in a book of this size, comprising only 91 pages, which serves, however, as a useful introduction to this very extensive subject. The first few chapters deal with the elementary principles of spectroscopy, spectroscopic equipment, the various types of spectra, and the methods of producing them. This leads to the consideration of spectrum analysis, including various quantitative methods and examples of their applications in the analysis of metals, waters and foods, with special reference to the detection and estimation of constituents present in minute

quantities. Absorption spectra are treated in succeeding chapters and their use in the examination of blood sera, glasses, dyes, alkaloids and inorganic salts is briefly described.

Dr. Judd Lewis is obviously an enthusiast in his subject, but he fully realises its limitations and points out that purely chemical methods of analysis are still preferable for the estimation of the main constituents of inorganic material, whereas for the estimation of most minor constituents, especially if only present in minute traces, the spectroscope cannot be surpassed.

BOOKS RECEIVED FOR NOTICE

THE DISCOVERERS OF THE FIJI ISLANDS. Tasman, Cook, Bligh, Wilson, Bellingshausen. By G. C. Henderson, M.A. Pp. xviii + 324, 9 × 6. (London : John Murray, 1933.) Price 18*s*.

INLAND WATERS OF AFRICA. By S. and E. B. Worthington. Pp. xix + 259, 9 × 6. (London : Macmillan & Co., Ltd., 1933.) Price 15*s*.

RAILWAY AND CUSTOMS POLICIES IN SOUTH AFRICA, 1885–1910. By Jean Van Der Poel, M.A., B.Ed. (Cape Town), Ph.D. Pp. 151, 8¾ × 5½. (London, New York, Toronto : Longmans, Green & Co., 1933.) Price 7*s*. 6*d*.

THE FOUNDATIONS OF AGRICULTURAL ECONOMICS, together with an Economic History of British Agriculture during and after the Great War. By J. A. Venn, Litt.D. Pp. xx + 600, 9½ × 6½. Second Edition. (Cambridge and London : The Cambridge University Press, 1933.) Price 25*s*.

The H.E.A. Year Book, Volume II, 1933. Hon. Editor : R. T. Pearl, B.Sc., A.R.C.S., D.I.C. Pp. xxxiv + 126, 9¾ × 6¼. (Wye, Kent : The Horticultural Education Association, 1933.) Price 3*s*. 6*d*.

COFFEE FROM GROWER TO CONSUMER. By B. B. Keable, Revised by C. J. Parham. Third Edition. Pp. vii + 124, 7¼ × 4¾. (London : Sir Isaac Pitman & Sons, Ltd., 1933.) Price 3*s*.

MODERN TEXTILE MICROSCOPY. By John Massey Preston, B.Sc., A.I.C., F.R.M.S. Pp. xi + 315, 8¾ × 5¾. (London and Manchester : Emmott & Co., Ltd., 1933.) Price 15*s*.

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